SER2011

WORLD CONFERENCE ON ECOLOGICAL RESTORATION

Re-establishing the Link between Nature and Culture

Book of Abstracts

4th World Conference on Ecological Restoration
20th Annual Meeting of the Society for Ecological Restoration
2nd Meeting of the Ibero-American & Caribbean Ecological Restoration Network

Mérida, Yucatán, México

SUNDAY, AUGUST 21 – THURSDAY, AUGUST 25, 2011

HOSTED BY THE SOCIETY FOR ECOLOGICAL RESTORATION
**SER2011**

**BOOK OF ABSTRACTS**

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The Mayans, renowned for their architectural, artistic, mathematical, and scientific achievements, left us a series of gigantic stone monuments and pyramids with precise astrological computations that reflect their understanding of the symbiotic relationship between the earth and the cosmos, and which many have interpreted as prophecies. The Mayans believed that these celestial cycles coincided with the development of our collective consciousness, and that the movements of the heavenly bodies exert influences upon the earth’s biosphere. As we approach the last year of the present great cycle (3113 BC – 2012 AD) and enter the “Age of the Fifth Sun”, the planetary alignment on December 21, 2012 forecasts major shifts in our evolution that afford us tremendous opportunities for the renewal and restoration of balance and harmony between nature and culture.

Logos command our attention; they are symbols or icons that encapsulate a myriad of realities. In Greek, logos is the animating spirit – the reasoning principle throughout time. The SER2011 conference logo of the macaw and agave plant depicts the intimate and mutually-supportive relationship of fauna and flora in nature. The scarlet macaw, which was revered by the ancient Mayans as a representative of the divine, is now on the brink of extinction due to habitat loss and the pet trade. The agave plant was domesticated by the Mayans as a source of fiber (sisal or henequén) and medicine. Its economic and cultural significance continued after colonization with the growth of the sisal industry until its collapse in the 1930s. The terms extinction and collapse are now commonly used by scientists and practitioners in the field when speaking of populations, species and ecosystems.

The SER2011 conference logo represents the interconnectedness of nature and culture – the need and desire for beauty and utility. As environmental degradation encroaches upon our lives, we are now forced to address the current trajectory of nature’s feedback mechanisms. Restoring balance, integrity, and resilience; re-establishing ecosystem structure and function; and reinstating ecosystem services is the monumental task before us. Ecological restoration is perhaps one of our most important tools for dealing with the adverse impacts of climate change, habitat loss, and species extinctions while at the same time providing for sustainable livelihoods.

The SER2011 conference will be an important forum for addressing the global challenges of biodiversity and habitat loss, climate change, and sustainable development. It will provide a global venue for professionals, researchers, students and the public to come together, learn and share their knowledge and experiences, and identify practical solutions for restoring nature and its critical ecosystem goods and services. SER2011 will bring together restoration professionals, researchers, and students from diverse backgrounds including the earth sciences, landscape architecture, ecological engineering, natural resource and land management, public policy and economics, and indigenous peoples and community organizers. It will provide a critical platform to assist us in defining the principles of restoration, understanding its methods and goals, and closing the gap between the science of restoration ecology and the practice of ecological restoration.

The SER2011 conference will include presentations and discussions on cutting-edge research and new developments in the science and practice of ecological restoration as well as numerous exciting networking opportunities. The SER2011 Conference Organizing Committees and Scientific Program Committee are proud to announce an innovative thematic program for the 4th World Conference on Ecological Restoration. Each of the three days of the scientific program will feature a morning plenary that will address in turn the economic, social, and biodiversity aspects of ecological restoration. Each plenary will consist of a keynote address and panel discussion followed by a press conference. The late morning and afternoon of each day will feature 12-14 concurrent sessions including regular and special sessions, symposia, and workshops.
SER2011 PLENARY PROGRAM

MONDAY, AUGUST 22, 2011 – THE ECONOMIC ASPECT

Ecological restoration as a tool for employment creation and sustainable development

KEYNOTE: Pavan Sukhdev
Special Advisor and Head of UNEP’s Green Economy Initiative & Study Leader for The Economics of Ecosystems and Biodiversity (TEEB)

PANELISTS: Sven Wunder (Center for International Forestry Research), Ani Adiwinata Nawir (Center for International Forestry Research), Keith Bowers (Biohabitats, Inc.),

TUESDAY, AUGUST 23, 2011 – THE SOCIAL AND CULTURAL ASPECT

Integrating ecological restoration with social and cultural values

KEYNOTE: Eric Higgs
Professor and past-Director, School of Environmental Studies, University of Victoria

PANELISTS: Leanne Liddle (Department for Premier and Cabinet, Aboriginal Affairs and Reconciliation, South Australia), Theresia Nkafu Atenkeng (Pan African Institute for Development, Cameroon), Victor M. Toledo (Autonomous University of Mexico - UNAM)

WEDNESDAY, AUGUST 24, 2011 - THE BIODIVERSITY AND ECOSYSTEM ASPECT

Using ecological restoration for enhancing biodiversity and ecosystem functioning

KEYNOTE: Shahid Naeem
Professor, Department of Ecology, Evolution, and Environmental Biology, Columbia University

PANELISTS: Elise Buisson (University of Avignon, France), Peggy Fiedler (Natural Reserve System, University of California), Gabriela Chavarria (US Fish and Wildlife Service)
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Restoring habitat complexity in the San Francisco Estuary: Artificial reef utilization by native oysters (Ostrea lurida) and salmon smolts (Oncorhynchus tshawytscha)

Abbott, Robert; Rena Obernolte
ENVIRON International Corporation, USA

Habitat complexity in North American estuaries has been reduced by filling the peripheral wetlands to create surface areas for urbanization, and dredging to remove hazards to navigation resulting in vast sub-tidal mud flats with no vertical hard surfaces for attachment by sessile organisms or interstices and rugosity affording microhabitats for a community of organisms and a robust food chain. Limited foraging opportunities in the Bay are considered a risk factor for salmon smolts. Artificial reefs composed of mounds of bagged Pacific oyster shell have been successfully used to create habitat for the settlement of native Olympia oyster spat (Ostrea lurida) and spawning habitat for the Pacific Herring (Clupea pallasi). Reef balls constructed of material dredged from San Francisco Bay installed near the mounds of bagged oyster shell provided additional habitat for fish and shellfish. Two 1/10 ha. reefs were constructed in the Bay using hundreds of volunteers and large private sector donations of services and materials. Based on the success of these two reefs, larger reefs are being planned for construction in the Bay to address the need for additional habitat complexity and to test living shorelines as a response to sea level rise. The reefs provided a robust halo of organisms around the mounds that served as forage for Chinook salmon smolts (Oncorhynchus tshawytscha) and steelhead (O. mykiss). The utilization of the artificial reef habitat by sharks, sturgeon, salmon and striped bass was confirmed by the detection of acoustically tagged fish using Vemco 69 KHz receivers.

Validating the utilization of levee mitigation features by acoustic tracking

Abbott, Robert; David Smith, Rena Obernolte, Phil Sandstrom
ENVIRON International Corporation, USA

Mandated modifications to Sacramento River levees to benefit migratory salmon smolts are expensive and controversial. Two dimensional tracks of the migration path of Chinook salmon smolts (Oncorhynchus tshawytscha) past four types of levee repair features was tested in the 2009-2001 season using arrays of Vemco 69KHZ receivers. The levee repair features included slope, bench, Dietl Ditch, and the installation of large woody material in the levee banks, compared to natural sections of levees with old growth trees and dense vegetation on the banks. A single reach over one kilometer long was studied in 2010-2011 using 69 KHz and 180 KHz Vemco receivers. Tags as small as 0.6 gm were inserted into the abdomen of salmon smolts ranging in size from 80-mm 180-mm long. The acoustic detections were used to triangulated on the position of the fish, rendered to latitude and longitude positions and used in a hydrologic based model, Eularian-Lagrangian-Agent Method (ELAM) to link fish behavior with hydrologic sheer. Differences in migration rate, utilization of installed woody materials and survival rates are discussed.

Electrical currents stimulate coral branching and maintaining growth forms

Abdallah, Khalid; Neviaty P. Zamani, Karen V. Juterzenka
Bogor Agricultural University, Indonesia

Field transplantation experiments using the Biorock technique under low voltage (3 V, and 6 A) direct current were carried out on two hermatypic reef-building corals, Acropora tenuis, and Acropora cytherea from April to November 2009 in Pramuka Island, Java, Indonesia. The first species has open three-dimensional branching, the second is a flat table coral. Growth and survival rates of corals transplanted on the Biorock artificial reef were compared with those of corals transplanted on uncharged control structures. After 7-months the electrically charged growth rates were 1.5 times higher than controls for A. tenuis and 2 times higher for A. cytherea. The number of branches of A. tenuis, were about 2 times higher on Biorock than on Control, A. cytherea showed little difference, perhaps due to its flat morphology. Higher survival rates on Biorock (100%) than on Control (73.3%, and 83.3%) were found for both species. The data presented refer to survival rate as a number of corals found in original position and alive on the respective structures, but some of them disappeared due to the wave action or biogenic disturbances such as fish
The experience gained since the programme started shows that it is an international programme established to provide education in ecological restoration and sustainable management of ecosystems. The programme is rooted in the UN Convention to Combat Desertification (UNCCD) and also strongly relates to the UN Convention on Biodiversity (UNCBD). A training programme in early 2010. The programme is aimed at training professionals from poorer countries of the world in ecological restoration and sustainable management of ecosystems. The UNU Land Restoration Training programme is designed to help improve the productivity of the land and promote the welfare and survival, particularly in poorer countries of the world where peoples' livelihood is directly dependent on the productivity of the land. A critical part of the solution to this challenge is through education and training in ecological restoration and sustainable management of ecosystems. The programme is expected to accelerate in the coming decades, leading to soil erosion, loss of biodiversity, and disruption and dysfunction of ecosystem processes. Its effect threatens human welfare and survival, particularly in poorer countries of the world where peoples' livelihood is directly dependent on the productivity of the land. A critical part of the solution to this challenge is through education and training in ecological restoration and sustainable management of ecosystems. The UNU Land Restoration Training programme (UNU-LRT) is an international programme established to provide education in ecological restoration and sustainable land management. The programme is built to meet the growing demands of expertise knowledge in this field in the poorer countries of the world. The programme started as a pilot project in 2007 and became recognized as a UNU training programme in early 2010. The programme is rooted in the UN Convention to Combat Desertification (UNCCD) and also strongly relates to the UN Convention on Biodiversity (UNCBD) and UN Framework Convention on Climate Change (UNFCCC). The experience gained since the programme started shows that it is an
excellent channel of communication and fulfils a much needed venue for exchange of ideas between individuals in different countries, continents and climatic belts that all are working towards the common goal of halting land degradation with sustainable and ecologically sound solutions.

**Retos y desafíos de la restauración ambiental de ecosistemas socioculturales**

**Aguilar Garavito, Mauricio; José Ignacio Barrera-Cataño, Luis Fernando Prado-Castillo**
Pontificia Universidad Javeriana, Colombia

La Escuela de Restauración Ecológica-ERE de la Pontificia Universidad Javeriana es un espacio creado para personas que quieran recomponer el rumbo de degradación que llevan los ecosistemas, en especial los de Colombia. Desde su creación, en 2002, se trabaja en la formación, capacitación y desarrollo teórico-práctico de la ecología de la restauración y la restauración ecológica. Para ello, se identifican dinámicas que posibiliten un cambio progresivo de la relación sociedad–naturaleza. De igual manera, a través de procesos individuales y colectivos se facilita la apropiación del territorio a intervenir, contribuyendo al fortalecimiento de una cultura de la conservación. Los participantes de estos procesos confluyen en una línea de pensamiento y actuación, buscando una visión plural y unificadora de la naturaleza y de la restauración como forma concreta de posibilitar su estabilización en todas dimensiones. La ERE ha permitido a sus integrantes el reencuentro personal, la reinterpretación del ser, el estar y el sentir. Su filosofía involucra representaciones simbólicas, valores, actitudes y opiniones de sus integrantes, así como una interpretación de la realidad social individual y colectiva con relación al espacio a restaurar. Estos principios han generado procesos para devolverle la estructura y función a los socio-ecosistemas del país en el marco del proceso de cambio global: En la ERE la restauración ecológica es una oportunidad de vida.

**Simposio de restauración ecológica de ecosistemas afectados por la invasión de especies exóticas**

**Aguilar Garavito, Mauricio; Adrián Escudero, José Ignacio Barrera, Sandra Patricia Montoya Villarreal, Aida Ortega**
Pontificia Universidad Javeriana, Colombia


**Neotropical rainforest soil and cover uses, degradation and restoration needs**

**Aguirre Rivera, Juan Rogelio**
Instituto de Investigación de Zonas Desérticas, Mexico

The use of rainforest main resources (soil and vegetation) presents an intensity gradient from the sudden clearing for establishing crop or forage plants, to the maintenance of mature vegetation tract with only conservative extractions. According to the human disturbance pattern (intensity, duration, frequency, fires, and plant cover type established or induced), there will be the risk of degradation and its deepness, and in turn the type of restoration possibly required. Monoculture of annual crops, may cause fast laterization, severe weed invasion and field abandonment. An overgrazed pasture becomes invaded by non forage pyrophyte grasses, nutrients exhausted and compacted by trampling, and finally is also abandoned. Certain tree crops and tree wood plantations, as well as slash and burn milpa (SB) without land availability imbalance, may maintain soil fertility, but well managed pastures and plantations always destroyed vegetation, and the non dislocated SB causes a lower impact. Partial or null mature vegetation elimination has lesser risk of degradation. Rainforest under selective extraction of wood species needs only protection from other perturbations to get corresponding natural repopulation. Partial clearing to establish pastures with a tree stand of certain composition and density may cover diverse needs others tan forage and maintain soil fertility. Techniques and impacts of traditional plantations into the rainforest, like coffee and cacao rustic ones,
shady orchards and diverse multipurpose species enrichments have to be known and evaluated. Finally, the least risky cases of degradation and less restoration needs are those of mature vegetation tracts with very low intensity of extractions because owners conscience to protect them.

Hydrological connectivity as a design element affects ecosystem functions in created wetlands
Ahn, Changwoon; Mary A. Voytek, Rita M. Peralta
George Mason University, USA

Denitrification is one of the key biogeochemical functions of natural wetlands and denitrifying bacteria play a significant role in it due to their ability to convert nitrate to gaseous N₂, but little has been known about the role of bacterial community composition in the process. Moreover, there are currently no specific methods and/or designs that would enhance the development of the biogeochemical function in created wetlands. The objective of this study is to investigate the influence of hydro-connectivity (HC) as a design element on the developments of soil and plant communities, denitrification potential (DP), and denitrifying bacterial community structure and diversity in created wetlands. It is hypothesized that wetlands created with greater HC would better support developments in bacterial communities (e.g., denitrifiers) and in biogeochemical functions (e.g., denitrification). We attempt to establish a quantitative relationship and/or association between structural (i.e., denitrifying bacterial community diversity) and functional measures (i.e., DP), which will help us evaluate functional development in wetlands created to mitigate the loss of natural wetlands. The study was conducted in three created and two natural wetlands in the Piedmont region of Virginia. The project is currently on-going, so preliminary data analyzed will be presented. The outcomes of the study will be explained in such ways that we can improve the design of created/restored wetlands to truly restore ecosystem service of wetlands for water quality improvement.

Impacts of marsh desiccation on water buffalo
Al-Fartosi, Khalid
University of Thi-Qar, Iraq

Archaeological evidence suggests that people brought water buffalo [domestic Asian water buffalo (Bubalus bubalis)] into Iraq’s Mesopotamian marshes, the low-lying, flat, riverine territory of the Tigris and Euphrates Rivers near their confluence in southern Iraq, around 3,500 B.C. For the Marsh Arabs of those early cultures and into the last century, traditional management of the marshes for water buffalo forage provided dairy products and buffalo dung was mixed with reeds to make fuel for cooking and heating fires and to waterproof roofs and poultice wounds. With the post-Saddam return of waters to marshlands and consequent restoration of functional and cultural features of the marshes, the reintroduction of these animals will reestablish important cultural and ecological management traditions of the marshlands. For the marsh dwellers, buffalo are a sign of economic well being and wealth; Iraqi hospitality traditionally included sharing dairy products and meat. Successful reintroduction of buffalo must take into account needs for adequate nutrition and changes in breeding and management approaches in order to promote improvements in buffalo stock. Recognition and management of reported hormonal irregularities and reproductive seasonality as well as during long calving intervals are important factors in stock improvement. Milk production improvements may come with better nutritional status at time of calving, better reproductive hygiene, better milking management, earlier detection of estrus in females, artificial insemination, managed thermal stress, and improved housing. Healthier stock will help return important ecological functions to the restored marshes.

Cultural and ecological restoration of the al-Ahwar wetlands, Iraq
Al-Handal, Adil Yousif
Basrah Marine Science Center, Iraq

Hawizeh Marsh was designated a Wetland of International Significance, and Iraq’s first Ramsar site and considered as a peace park between Iraq and Iran. Simultaneously to the marshes being awarded international conservation status, Iran began diverting water from the Karkheh River. As a result of this action, the Safia Wetland Conservation in Huwaiza marsh is now completely dry. Marsh ecosystem is now in poor condition, and less than 10% of the original marshes in Iraq remained as fully functioning wetlands. Now drought and water withdrawals are desiccating the marshes, and pollution of water, air, and land is extremely severe. With low flows, salinity in the Shat al Arab River has increased. Flows are significantly reduced from 990-1,277 m³/sec in 1977-1978 to <100 m³/sec in 2008-2009. Sea water has started to reach far to the north of the Shat al Arab, with big changes in the biodiversity. Shad populations have declined 75%. Many other invertebrates are also declining, and the salty turbid water with warmer temperatures is adversely affecting fish production and biodiversity in the Gulf. The marshes are a culturalized
Coastal oil pollution in Kuwait: Twenty years after the 1990/1991 war, Subbiya Oil Trench case study

Al-Hasan, Redha
Kuwait University

The 1990/1991 War resulted in severe environmental damages to marine, coastal and terrestrial ecosystems in Kuwait and affected neighboring countries. An elaborate environmental claim process and follow up program were initiated by the United Nation Compensation Commission. The follow up program funded an initial stage of Monitoring and Assessment (M&A) and provided for a second phase of remediation and restoration. The results of the M&A estimated that more than 500 million gallons of crude oil were deliberately spilled into the coastal and marine environment of the State of Kuwait during the war, taking various forms such as coastal oil deposits, coastal oil trenches, weathered coastal layers and residual contamination. This study focuses on the oil contaminated trenches in Subbiya area north of Kuwait Bay. Over the years the trenches have been filled with deposited sediment, but the hydrocarbon contamination level did not shows comparable levels of total petroleum hydrocarbon contamination. Photographs from the M&A phase documents that the areas surrounding the oil trench was barren of macro fauna and flora, and the flat was only covered by algal mats. Characteristic macro fauna and flora has re-colonized the stretches on both side of the trench, however the toxicity of the trench prevents any re-colonization on top of the trench itself.

La restauración ambiental para la producción de funciones y servicios ambientales en el Parque Estatal Sierra de Guadalupe, zona metropolitana del Valle de México

Alberto Villavicencio, Ángeles
Universidad de Granada, México

Las áreas protegidas ubicadas en zonas peri-urbanas presentan un doble reto; atender los objetivos de conservación vinculados a las especificidades de los ecosistemas que representan, y enfrentar los procesos de uso de las funciones ambientales por las zonas en expansión urbana, como son; la generación de elevados niveles de contaminación y procesos de ocupación del suelo típicos de la urbanización difusa. El deterioro de los ecosistemas y la saturación de sus funciones ambientales en la Zona Metropolitana del Valle de México (ZMVM), impulsa su restauración ambiental desde diversos niveles de actuación y tipos de proyectos. En el Parque Estatal Sierra de Guadalupe (5,306.75 ha) se han realizado proyectos de restauración ambiental con la iniciativa pública interestatal del Estado de México y el Distrito Federal y financiamiento tripartita entre ambos y el Banco Interamericano de Desarrollo (Proyecto de Conservación Ecológica de la Zona Metropolitana del Valle de México, entre 1992 y 2004). Se presenta un análisis de la eficiencia de las acciones de restauración por microcuenca y componente (realizadas durante doce años), en cuanto a producción de funciones y servicios ambientales, su contribución a la solución de los problemas más álgidos de este parque, representativo de la ZMVM en su complejidad ambiental, social y territorial. El esquema propuesto evaluó el alcance de las acciones de restauración, utilizando la categoría de funciones y servicios ambientales para subrayar los beneficios obtenidos por los usuarios de los ecosistemas del parque, cuya importancia trasciende a su dimensión ambiental y geográfica actual al proporcionar múltiples servicios.

Ethno-environmental study of resilience to climate change, Tauna Barrage Wildlife Sanctuary, Pakistan

Ali, Zulfiqar; Saima Yaqub, Shelly Iam, Colbeck Zaheer, Ahmad Nasir Syed, Saleem Ahmad
University of the Punjab, Pakistan

Protected areas around the world are more prone to have negative effects of climatic variations that are disturbing the stabilization of ecosystems. Tauna Barrage Wildlife Sanctuary was studied to be the reference site, where climatic change factors were recorded and resilience of rural community to these changes was analyzed. A questionnaire of participatory human resource interaction appraisal was used to assess the socio-economics of rural communities, mega-biodiversity of the area, perception of local communities about climate change and their resilience capacity. Climatic factors like temperature and rainfall were proportionally changed as the data assessed from 1951-2010 and rural communities around Tauna Barrage Wildlife Sanctuary were also agreed (85% n = 100) to realize the
phenomenon of climatic change. These communities have proved to be resilient (94% n = 100) to adapt to it by changing occupations and lifestyles, but at the same time they have increased the pressure on natural resource use and cause a serious problem in the management of the protected area due to low literacy rate, lack of awareness and unavailability of alternative income resources. Thus, showing the Taunsa Barrage vulnerability to climate change is in accordance with the Environmental Vulnerability Index of Pakistan.

Identifying the science for restoration: A review of the Gulf Coast Ecosystem Restoration Task Force Science Group

Allee, Rebecca
US National Oceanic and Atmospheric Administration

On October 5, 2010, the President of the United States signed an Executive Order establishing the Gulf Coast Ecosystem Restoration Task Force. The purpose of the Task Force is for federal agencies, in collaboration with Gulf State representatives, ‘to coordinate intergovernmental responsibilities, planning, and exchange of information so as to better implement Gulf Coast ecosystem restoration and to facilitate appropriate accountability and support throughout the restoration process’. The Task Force was charged to present to the President a Gulf of Mexico Regional Ecosystem Restoration Strategy in the fall of 2011. Several work groups were established to provide support for the development of this strategy. One such group was given the responsibility to consider the science needs and put forward recommendations for high level activities which would establish the foundation for ecosystem restoration. The science group was organized into goal teams to address specific issues such as living marine resources, offshore, coastal and inland habitats, barrier islands, water quality, and community resilience. This presentation will define the structure of the Science Group and acquaint the audience with the high level activities that might be expected in the strategy.

Back from the brink of extinction: Improving the success of endangered plant translocations in south-western Australia

Allen, Christine; Pieter Poot, Michael Moody, Rachel Standish, David Coates
University of Western Australia

Translocations have become a relatively common technique used around the globe to augment populations of endangered species populations, with variable rates of success. South-western Australia is one of 34 global biodiversity hotspots predominantly due to its highly diverse endemic flora. Many of these endemic species are rare, have narrow distributions, and are consequently vulnerable to human activity. The increasing number of highly threatened species occurring in small fragmented populations has led to the translocation of seedlings as a strategy to conserve species. Past translocation studies in Western Australia have shown high seedling mortality, especially in their first summer. The present research aims to understand environmental factors influencing seedling growth and survival by establishing two experimental translocations. Critically endangered Banksia and Acacia species were exposed to a range of experimental treatments including variations in microhabitat, watering regimes and competition. The effects of these variables were measured using plant mortality and growth coupled with stress tolerance as well as quantifying abiotic (e.g. soil moisture, soil nutrient levels) and biotic variables. Results will be discussed in the context of climate change within south-western Australia. Ultimately, this research will form the basis for a comprehensive understanding of seedling microhabitat requirements, which will be used to inform future management decisions and improve the success of translocations.

A comparative study of global attitudes towards ecological restoration: Where have we been and where do we need to go?

Allison, Stuart
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Do ecological restorationists around the world have similar attitudes towards and goals for restoration? To answer that question I reviewed 677 papers published from 2006 until 2010 in Restoration Ecology, Environmental Management, Journal of Applied Ecology and Ecological Applications. I also conducted an on-line survey of restorationists. My goal was to understand the approaches to ecological restoration around the world with the objective of developing a framework from which restorationists can plan and implement restoration work of both ecological and cultural value. I found significant differences between geographic regions in reasons for performing ecological restoration. Restorationists in North America and Australia were more likely to restore ecosystems to
return ecosystems to their historic trajectory. European restorationists were more likely to restore ecosystems to preserve and promote biodiversity and ecosystem services. There was less information available about restorations in Africa, Asia, Latin America and Oceania, but there was evidence that restorationists in those areas tended to favor biodiversity and ecosystem services. Europeans were more likely to engage in restoration of culturally important semi-natural agricultural landscapes. There was some evidence of a generational split among restorationists with younger restorationists more likely to restore ecosystems to promote ecosystem services and having a somewhat flexible attitude towards restoration goals. Good ecological restoration must produce restoration projects with both ecological value and human meaning. The more explicitly we address both properties, the more successful we will be as restorationists and the more benefit there will be for the planet as we work together.

**Effect of site and seasonality in tropical dry forest restoration**

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Universidad Veracruzana, Mexico

In central Veracruz, tropical dry forest (TDF) has been reduced to 7% of its original cover. To restore the TDF, basic information on the role of existing vegetation is needed. Our objective was to determine the site condition effect on native tree species performance during dry and rainy seasons. The existing woody vegetation in the experimental sites differed in richness (8-18 species/0.04 ha) and density (36 a 190 ind/0.04 ha) as a consequence of different land use intensity. A total of 960 seedlings (*Tabebuia rosea*, *Cedrela odorata*, *Guazuma ulmifolia*, *Ceiba aesculifolia*, *Luehea candida* and *Ipomoea wolcottiana*) were transplanted in four experimental sites. Survival and growth were monitored every 4 months during 2 years. Seedling survival was higher in sites with denser existing vegetation condition that nurses seedlings, but survival was not consistently lower for all species during the dry seasons. Relative growth rate (RGR) was higher for all species and sites during the rainy season. In the most degraded site, seedling performance was poor and only Guazuma survived the experimental period. Overall, Ceiba showed the highest survival (82-90%) and low RGR; Guazuma has a high survival (20-94%) and the highest RGR; on the contrary Cedrela showed the lowest survival (3-7%) but high RGR. Our results suggest that site condition, seasonality and species drought tolerance act together on seedling performance during the restoration assays. In conclusion, the site condition is as important as tree species selection in a successful restoration of TDF.

**Agenda 21 Local: formando y accionando con el Grupo Temático, "Endemismo Local Santaclareño", para restaurar ecológicamente un área de endemismo en estado crítico, en la ciudad de Santa Clara, VC, Cuba**

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Agenda 21 Local Santa Clara ha proporcionado instrumentos metodológicos para el desarrollo de acciones que se incorporan y contribuyen hoy al perfeccionamiento de las políticas urbano-ambientales municipales. El GEO Santa Clara, ha determinado dentro de una de las problemáticas en la ciudad, el insuficiente trabajo interdisciplinario de grupos afines a una determinada temática a resolver, por lo que, la formación de Grupos Temáticos ha constituido una herramienta de trabajo no sólo para los tomadores de decisiones, sino también para la ciudadanía en general. El Grupo Temático “Endemismo Local Santaclareño”, formado por actores implicados y la comunidad, fortalecido con la igualdad de género, el empoderamiento de mujeres, la participación e inclusión de ellas en esferas de decisión, está trabajando para lograr la restauración ecológica de un área en estado crítico, situada al suroeste de la ciudad con extraordinario valor científico. En ella se conservan especies de vegetación original de matorral xeromorfo espinito sobre serpentinitas con valores únicos e irrepetibles desde el punto de vista florístico. Una especie de las reportadas es exclusiva de esta localidad, o sea, su único hábitat en el planeta. Integrar el área descrita a la vida urbana, mediante acciones de restauración, el uso público y la educación ambiental, como vía de fortalecer las capacidades ciudadanas, es el reto que asumimos para restablecer la unión entre Naturaleza y Cultura.

**Fauna epigea de un suelo en recuperación por 18 años**

Alves, Marlene Cristina; Carolina dos Santos Batista Bonini, Ricardo Antonio Ferreira Rodrigues, Débora de Cássia Marchini, Otton Garcia de Arruda

Universidade Estadual Paulista, Brazil

La fauna del suelo es un importante indicador de su cualidad, pues ejercen función en la reciclaje de nutrientes e en la estructura del suelo. El objetivo de este estudio fue investigar un Ferralsol degradado que se encuentra bajo las técnicas para su recuperación hace 18 años, en Brasil. El diseño experimental fue completamente al azar con siete
tratamientos y cuatro repeticiones. Los tratamientos fueron: Solo con labranza (vegetación espontánea); *Stizolobium aterrimum* (Sa); *Cajanus cajan* (Cc) hasta 1994, después sustituido por el *Canvalia ensiformis* (Ce); Sa+caliza; Cc+caliza hasta 1994, después sustituido por Ce; Sa+caliza+yeso; Cc+caliza+yeso hasta 1994, después sustituido por Ce. Los tratamientos se mantuvieron durante siete años, y en 1999 se llevó a cabo en toda la área experimental la *Brachiaria decumbens*. En 2010 fue evaluado la fauna epigea, la materia orgánica del suelo y la temperatura del suelo en tres capas del suelo. Los resultados fueron analizados mediante la realización de análisis de varianza y prueba de Scott-Knott, el 5% de probabilidad para la comparación de promedio. La fauna epigea del suelo se vio afectada por los tratamientos utilizados para recuperar el suelo y había una mayor diversidad y número de individuos en los tratamientos con abono verde utilizando el *Stizolobium aterrimum*.

**The impact of plant biodiversity changes of the marshes of southern Iraq (mesopotamia) on the Shatt al Arab and Northern Gulf**

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Aquatic plant biodiversity (species diversity, richness and evenness) including plant cover and biomass, in addition to water quality and soil chemistry, were studied in the marshes of Southern Mesopotamia, Iraq. Samples were collected from six stations (2 stations in Huwaiza, 2 in Chebaish, and 2 in Hammar) in 2007 and 2008. A total of 44 plant species were recorded. The highest value of diversity and richness was recorded in the Huwaiza marsh while the evenness was the same in all marshes. The number of plant species collected during the two years of sampling was less than that recorded in the past, approximately one half of previous records. Physical and chemical characteristics of water and soil were determined and their impact on the changes in plant biodiversity will be discussed.

**Innovative solutions for the environment and people of the Mesopotamian marshes of southern Iraq**

Alwash, Azzam
Nature Iraq/Twin Rivers Institute

The Mesopotamian marshes of southern Iraq are not only important from the point of view of biodiversity in an arid region like the Middle East, but also represent a World Heritage site. In an era of increasingly limited water resources and increased demands on the limited water, will the marshes survive? The marshes were dried by the regime of Saddam Hussein to get rid of his opposition. Along with the drying of the marshes, dams were built upstream in Turkey and Iran, restricting river flows which maintain the marshes. The people of the marshes (Ma'adan) returned the water to the marshes, and some 56% of the marshes of 1973 came back to life. However, the biodiversity of the rehydrated marshes is radically different than historic marshes. This is due to the loss of spring flooding that maintained marsh biodiversity. Low flows in the Tigris and Euphrates Rivers result in increased water salinity and pollution. In addition, polluted and saline irrigation return flows containing pesticides and nutrients are released back into the rivers from primitive irrigation methods being practiced in Turkey, Iran, Syria and Iraq. To complicate the picture further, large reservoirs of oil underlay the marshes. This presentation will discuss innovative solutions implemented by Nature Iraq that will assure the survival of the marshes for the sake of the environment itself and the people who live off the marshes, and to preserve this world heritage site the people of which are considered to be the inheritors of the Sumerian culture.

**Impacts of reduced flows and impaired water quality in the Shatt al Arab to fish productivity, biodiversity and socio-economics in the Northern Gulf**

Al Yamani, Faiza
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Shatt Al-Arab River, formed by the confluence of the Tigris, Euphrates and Karun Rivers, is a major source of lower water quality into the Arabian Gulf. The productivity of Kuwait waters and its water quality is linked to the discharge of Shatt Al-Arab River into the northern Arabian Gulf. The northern Arabian Gulf of Kuwait’s marine environment is regarded as important fish and shrimp nursery habitats. Many of the commercially important species (shrimp *Metapenaeus affinis*, pomfret/zobaidy *Pampus argenteus*, shad/suboor *Tenualosa ilisha*, yellow-fin seabream/sheim *Acanthopagrus latus* and others) are directly dependent on the Shatt Al-Arab River as well as the marsh and estuarine areas for spawning, feeding and as a nursery habitat. Therefore, any changes in the volume or
Characteristics of the fresh water regime could have devastating effects on the distribution and abundance of the above species. Once the Southeast Anatolian Project in Turkey (22 dams on the Tigris and Euphrates Rivers) is fully implemented, water flows will be reduced and water quality impaired, damaging fishery productivity for Kuwait’s shrimp, silver pomfret, and hilsa shad. In general, the present information and sporadic data is insufficient to assess the impact of changes taking place in the estuarine areas of Kuwait’s waters. It is recommended to establish a long-term oceanographic sampling program (monthly basis) to sample the riverine, estuarine and northern Gulf areas for a 10- to 20-year period. Potential impacts related to the food chain and fisheries will be addressed in the presentation.

El conocimiento local en el uso y manejo del recurso agua: Un caso de estudio del Parque Nacional Nevado de Toluca
Anastacio Martínez, Nancy Diana; Alicia de Cruz, Sergio Franco Maass, Gabino Nava Bernal, Tizbe Arteaga Reyes
Universidad Autónoma del Estado de México

Actualmente la crisis ambiental causada por la explotación de los recursos forestales y el cambio en la ocupación de la tierra tiene como consecuencia la crisis mundial del agua y la reificación de los recursos hídricos del planeta, ante dicho panorama se debe involucrar al ser humano en el proceso de conservación del recurso como resultado de la relación hombre-naturaleza. El trabajo de investigación se desarrolla en la comunidad rural de La Peñuela del Parque Nacional Nevado de Toluca, dicha comunidad es una de las 23 localidades que se encuentran ubicadas dentro del área natural protegida y se ha caracterizado por el desarrollo de la agricultura de riego. En este tenor se plantó como objetivo principal el determinar el estado actual del recurso hídrico desde la perspectiva del conocimiento local, considerando como elemento importante la percepción de la gente sobre su medio, utilizando métodos cualitativos, donde se manejaron aspectos como la participación directa, la observación participante, las entrevistas semi-estructuradas y talleres participativos. El principal aporte está enfocado en concientizar a la gente sobre el estado de sus recursos para que mediante su conocimiento sean capaces de conservar su recurso a nivel local y regional, así mismo en La Peñuela se presenta una fuente demanda del recurso por el desarrollo de la agricultura de riego enfocada al cultivo de papa y otros cultivos básicos, no obstante existe una gran fragmentación dentro de la comunidad por la división de tres sectores originados por la demanda y fuentes de abastecimiento del agua.

Participatory ecological restoration in the Río Blanco watershed: Ecosystem-based adaptation actions to address climate change impacts in the Chingaza Massif, high mountain ecosystems of Colombia
Andrade, Angela; Angélica Cardona, Klaus Shutze
Conservation International, Colombia

The most vulnerable ecosystems to climate change in Colombia are High Andean mountain ecosystems, dry zones and marine and coastal areas. High Mountain ecosystems, including “paramos” are located above 2,740m and represent about 4% of the national territory. In addition to temperature increase, these ecosystems would have significant rainfall changes, affecting the provision of ecosystem services, especially water availability of main cities and settlements and potential hydropower. These climate change disruptions affect the ecological relationships, generating an increase in extreme events, occurrence of pests, extinction of species relevant for ecosystem function and provision of ecosystem services, including water availability, water regulation, and soil protection, among others. Ecosystem based adaptation actions are developed in the Río Blanco watershed, covering an area of 40,446 ha of the Chingaza Massif, which provides water consumed in Bogotá. Participatory ecological restoration in degraded agricultural lands is implemented for the reduction of adverse impacts of water regulation and building resilience to climate change. It includes 200 restoration processes of priority areas for water production, and 25 km of “live fences”. These processes are strongly linked to integrated risk management, land use and farm planning in 2 municipalities and more than 100 local farms. 7,000 plants of 37 native species have been planted, an experimental center for the propagation and germination of high mountain native species and 10 satellite green houses have been built with the support of local communities. These adaptation actions might be replicated in similar areas.

Soil restoration with urban wastes to improve soil environmental services
Andrés, Pilar; Oriol Ortiz
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Among the organic wastes generated by cities, wastewater sludge and the organic fraction of the municipal solid wastes are being increasingly used as organic amendments for soil restoration, based on their high organic matter
content. Recycling of properly treated organic wastes through use as amendments not only helps to restore soil fertility but may also contribute to counteract global warming by sequestering carbon both in soil and in vegetation growing in the restored areas. In 1992, we started a field campaign in a limestone quarry, whose aim was to identify the most appropriate doses of sewage sludge to produce a new fertile Technosol from earthy inert materials. We set up twelve plots and allocated them to two treatments (7.5% and 15% sludge dose, w/w) and a control (no sludge) with four replications each. Spontaneous revegetation was allowed. In 1992 and 2009, we sampled these plots for soil organic matter content, aggregate size distribution, total and recalcitrant carbon and biological activity. Results demonstrate that soil amendment with sewage sludge results in persistent soil organic matter increase and stabilization over time. Seventeen years after soil amendment, the amended soils show higher C content than control and also a greatest proportion of recalcitrant C, mostly located in the biggest aggregates. Microbiological activity and fungal biomass were equal in control and treatments, suggesting no detrimental effects of sludge on soil microbiota. Our research group is now working on the carbon sequestration potential of pyrolyzed organic wastes applied to soil in the form of recalcitrant biochar.

Matching rural and scientific perceptions to improve environmental quality in livestock regions: The case of the "Mesas de Moropotente“ Protected Area (Nicaragua)

Andrés, Pilar; David Tarrasón, Federica Ravera
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In recent years, the term "degradation" has been reviewed for its multiple meanings, particularly when applied to silvipastoral tropical systems, which are themselves dynamic and highly unpredictable. Since these systems are valuable for environmental conservation, and since their productivity sustains local and regional economies, their degradation is perceived in different ways by different actors. Once again, depending on the actor’s particular idiosyncrasy, current condition and future expectations, a multiplicity of desirable and often mismatching solutions arise. Choosing the “best technical solution” to solve these complex problems often leads to theoretically correct but socially non-viable options. Our team led a four-year project intended for proposing viable management of an economically and environmentally degraded silvipastoral landscape in Nicaragua. Historical and institutional analyses allowed the identification of significant actors at different scales, as well as the way they interact with each other. After an agricultural census, and based on in-depth interviews of the land owners, we identified the farm-types of the area. Farms representative of each type were studied to build up resources (material, economic and work force) flux diagrams, and to describe the environmental conservation status. A participatory process was then started to accord global deficiencies, future scenarios and progress indicators. Under an “improvement of the traditional management” scenario, specific actions were defined at the farm-level, including agro-ecological systems, modifications of livestock management and reforestation of marginal lands. Alternatives were tested for their performance in field experiments and were evaluated based on the chosen indicators.

Restauración eco-cultural en la comarca Kuna Yala, importante para una resiliencia ante el cambio climático

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Fundación para la Promoción del Conocimiento Indígena, Panama

En la comarca Kuna Yala dicha relación es palpable, la cultura marca las acciones y actividades que se realizan en el bosque y viceversa, los conocimientos están muy relacionados con el manejo y uso ambiental, tal es el caso de los Nainus (áreas de cultivo), los Neg saret (bosque maduro), los galus (sitios sagrados), entre otros. No obstante, hoy día se están perdiendo, los jóvenes se han separado y le han dado poco importancia a los conocimientos tradicional, las casas del congreso están cada vez mas vacías, sumado a esto, las visiones occidentales de desarrollo estas erosionando los conocimientos y poniendo en peligro en manejo territorial del pueblo Kuna. En ejemplo de ello, son las políticas nacionales de medio ambiente, las cuales desde hace mucho tiempo han socavado los sistemas de manejo y gestión ambiental-cultural de la comarca. En la actualidad las políticas relacionadas a los mecanismos del cambio climático no están tomando en cuenta los conocimientos y acciones que tienen los pueblos indígenas, por ello se ha realizado una evaluación local sobre este tema, sus mecanismos, políticas, sus efectos sobre el medio ambiente y cultura, y las posibles acciones de restauración eco-cultural (salvaguardas, leyes, etc.) de este pueblo indígena milenario.
Experiencias de conservación y restauración de áreas de uso común: El caso de los Proyectos de la Comisión Nacional Forestal

Anta Fonseca, Salvador
Comisión Nacional Forestal, México

Experiencias de conservación y restauración de áreas de uso común: El caso de los Proyectos de la Comisión Nacional Forestal. En México existen experiencias sobre conservación y restauración de áreas de uso común que han partido de iniciativas de comunidades que han tenido el apoyo de organizaciones de la sociedad civil. Sin embargo los impactos y las escalas de incidencia han sido limitados debido al escaso financiamiento. Cuando estas experiencias encuentran el apoyo de los recursos públicos gubernamentales, y los programas respetan los procesos comunitarios y de la sociedad civil, los logros e impactos suelen ser mayores, y los objetivos de la conservación y restauración se pueden lograr más rápido. Los factores que permiten explicar estos avances son: el desarrollo del capital social que tengan las comunidades, el compromiso de las organizaciones de la sociedad civil, y la continuidad multianual el aporte de los recursos públicos gubernamentales. En México el ProÁrbol a sido la principal fuente de financiamiento a estos casos a través de sus componentes: a) conservación de suelos y reforestación; b) silvicultura comunitaria, con acciones que buscan fortalecer el capital social (Ordenamientos Territoriales Comunitarios, Reglamentos Ejidales, etc.), c) Servicios Ambientales Hidrológicos y de Biodiversidad; O proyectos especiales como el COINBIO que apoyan la conservación comunitaria. En esta ponencia se presentan casos de proyectos exitosos de restauración en la Mixteca Oaxaqueña y Chilapa, Guerrero; así como de conservación de áreas forestales comunitarias en la Chinantla, Oax; La Montaña de Guerrero; y la Cuenca del Copalita en Oaxaca.

Using design in landscape scale restoration

Apostol, Dean
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Many practitioners and academics agree that ecological restoration is both an art and a science. But most people engaged in restoration focus on the science and less on the art. One aspect of the art of restoration is the process of conscious design, or creating a vision of what the restored landscape will be like at some future date. Ecosystem managers often use the term “Desired Future Conditions” to explain this vision, but lack good tools for creating it. One challenge is that "design" is a word that raises red flags among scientists because it implies arbitrariness with respect to making choices. They worry that choices about the future will be driven by landscape appearance rather than ecological substance. But the future of ecosystems is rarely deterministic. It is shaped by a multitude of factors, including decisions made by the restorationist, by those who hire her, or those who live on or near the land. This presentation will explore the role of design and design tools in conceptualizing and analyzing alternative choices in restoration. The focus will be on landscape scale, primarily forested ecosystems that have varying degrees of cultural influence. It draws upon over 30 years of experience as a practitioner, researcher, writer, and teacher.

Dynamics of understory vegetation during woodland restoration on eroded land

Aradottir, Asa; Gudmundur Halldorsson
Agricultural University of Iceland

When restoring plant communities we often introduce only one or a few important plant species, expecting that in time they will facilitate the colonization and establishment of other species of the community. We studied the understory of birch woodland chronosequences in South Iceland to test the hypothesis that establishment of a birch tree layer will facilitate the development of understory vegetation communities of native birch woodlands. The chronosequences were established by planting or by natural regeneration from old seeded stands. All were on sites that were previously eroded and had been revegetated with seeding of grasses and fertilization. Furthermore, all were isolated from native birch woodlands by at least several kilometers. Old-growth birch woodlands, revegetated land and untreated eroded land were included for comparison. The species composition of vascular plant species and common moss species was analyzed with a DCA ordination, giving eigen values for the first two axes of 0.65 and 0.29. The understory plant communities changed markedly from young (5-15 years) to older (>50 years) restored birch woodlands and became increasingly more similar to the communities of old-growth woodlands with age. A few important woodland species were, however, not found in the understory of restored woodlands, possibly because of a dispersal barrier. Thus, while the establishment of a tree layer seemed to facilitate the development of important components of the understory vegetation, some species that are restricted to woodland habitats may not be able to spontaneously colonize the restored woodlands.
Aportes de la ecología humana al desarrollo

Aranda Espinoza, María Lidia
Universidad Nacional de Asunción, Paraguay

La ecología humana se basa en el fomento del desarrollo de las personas considerándolas como sujetos con voluntad propia y poder de decisión, y no como objetos, considerando las necesidades básicas del ser humano: alimentación, vestido, vivienda, salud, educación así como aquellas que potencian la calidad de vida, en función a las necesidades creadas por la cultura. Las necesidades básicas intrínsecas del ser humano se encuentran vinculadas con la calidad del ecosistema que lo rodea pues el mismo interviene en la provisión de los servicios ecosistémicos que redundan en beneficio de la satisfacción de las demás necesidades del ser humano. Es por ello que surge la importancia de vincular la conservación y restauración de los ecosistemas con proyectos de desarrollo y mejora de la calidad de vida de las personas, especialmente en países en vía de desarrollo, quienes poseen abundantes recursos naturales en buen estado (bosques, recursos hídricos, suelo biodiversidad), y desarrollan numerosos proyectos fomentando el desarrollo de comunidades humanas. Y también emerge la importancia de considerar y realizar un análisis crítico, con varias opiniones, sobre el aporte de la teoría de la ecología humana a proyectos de desarrollo en los cuales se puede incluir la estrategia de conservación y restauración de ecosistemas y fomentar la sinergia entre la mejora del ambiente y la mejora de la calidad de vida de las personas.

Integración ecosistémica en programas de restauración ecológica

Aranda Espinoza, María Lidia
Universidad Nacional de Asunción, Paraguay

El enfoque ecosistémico propone la integración de los diversos componentes de un ecosistema para el logro de un desarrollo sustentable tanto en manejo como en gestión de recursos naturales. Este mismo enfoque podría contribuir a logros mas amplios en proyectos de restauración ecológica al considerando no solo una especie particular sino toda la estructura y el funcionamiento integral. El presente aporte pretende generar un espacio de discusión de rescate de experiencias de programas de restauración ecológica con enfoque integral realizados en Paraguay como intercambio de ideas y generación de nuevos pensamientos e ideas.

Vínculos entre ecología humana y restauración ecológica: aportes de estrategias y metodologías

Aranda Espinoza, María Lidia
Universidad Nacional de Asunción, Paraguay

La ecología humana utiliza para sus estudios estrategias de acción participativas integrando a las comunidades en la toma de decisiones en proyectos de desarrollo, fomentando así la apropiación de los mismos y el empoderamiento de las comunidades más relegadas como: comunidades indígenas, poblaciones rurales. Sin embargo son estas las comunidades quienes viven, se desarrollan y manejan numerosos recursos naturales de los ecosistemas con mejor salud ambiental. En ocasiones se da un mal manejo de los ecosistemas, y se dificulta la implementación de proyectos de restauración ecológica, en sitios donde las comunidades humanas desconocen de los servicios que prestan sus ecosistemas o van las acciones de los proyectos impuestos por un ente superior y poco involucramiento del propio saber local. Esta presentación busca aportar numerosas estrategias y metodologías participativas propias del trabajo de la ecología humana como: diagnósticos participativos, identificación y jerarquización de problemáticas de riesgos desde la población local, mecanismos de rescate del saber cultural, de manera a emplearlos en los proyectos de restauración ecológica y así facilitar el involucramiento y empoderamiento de la población con las acciones y favorecer la sostenibilidad de las acciones, que muchas veces se ven limitadas por falta de gestión social asociada al proyecto.

Emerging findings from indigenous biocultural climate change assessments and ecocultural restoration

Argumedo, Alejandro
Asociación ANDES, Perú

This presentation will focus on providing an overview of the work that the Indigenous Peoples' Biocultural Climate Change Assessment (IPCCA), a global indigenous initiative on climate change is undertaking, and a synthesis of emerging results. Through local biocultural assessments of the impacts of climate change on communities, ecosystems and well being, the IPCCA is building innovative and alternative responses to the climate crisis and
associated impacts based on birding indigenous and local knowledge with science and appropriate technology. The core activities of the IPCC are taking place in indigenous communities around the world. Currently the IPCC initiative is facilitating nine (9) local biocultural climate change assessments carried out by indigenous partners and communities within key biocultural systems across the world. As these local actions are empowering communities and producing evidence-based responses that are locally appropriate and globally aware, a parallel process of conceptual and methodological development is lead by the Secretariat. The IPCC is guided by a conceptual framework that encapsulates the vision of all partners and a methodological toolkit combining intercultural dialogue, indigenous inquiry and emancipatory methodologies is enabling a coordinated approach through which results are synthesized and fed into policy development. The objective of this presentation is to share the emerging results for ecocultural restoration of indigenous territories in times of rapid climate disruption.

**Mayan milpa landscapes and sustainable agriculture in Yucatán**

Arias Reyes, Luis Manuel; José Vidal Cob Uicab
CINVESTAV-IPN, Unidad Mérida, Mexico

Historically the management of the rainforest by the Peninsular Maya peasants was focused on milpa slash and burn (SB) agricultural system, for staple food production (maize-beans-squash). This system uses the rain forest biological capital and generates a dynamic patchy landscape that depends on the frequency and intensity of human disturbance. The resulting agroecosystems can be defined as the following: (a) traditional milpa now using agrochemicals; (b) continuous milpa in deep red soils (kankabal); (c) the use of secondary vegetation or hubchés nectar and pollen production for beekeeping; (d) vegetation fringe of 20 m width bordering milpas, roads and cenotes, used as germplasm reservoir or tolchés; (e) mature vegetation in common land reserves around the town or fundos legales; (f) traditional agroforestry and livestock production based on homegardens or solares; (g) orchards and rainforest with diverse non timber materials extraction in the south of Yucatán; (h) traditional agroforestry ranching (milpa-induced grasslands or pastures, and hubchés cyclic sequence); (i) enrichment of hubchés with commercial wood tree species. At present time there is a widespread tendency for reduction of the fallow period of hubchés as a result of population growth, the reduction of areas for milpa cultivation and the increase in food demands for human population. In this context, the SB corn production, has been intensified through the generalized use of agrochemicals. Among the Mayan peasants reactions to this problem are the diversification of economic activities such as beekeeping, and fruit and vegetable production, as well as seasonal and permanent migration.

**What role should government regulation play in ecological restoration? Ongoing debate in São Paulo State, Brazil**

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Around the world, there is growing desire and momentum for ecological restoration to happen faster, with better quality, and in more extensive areas. The question we ask is: how can laws and governmental regulations best contribute to effective, successful and broad scale restoration? In the State of São Paulo, Brazil, there is a legal instrument (SMA 08-2008), whose aim is to increase effectiveness of tropical forest restoration projects in particular. It establishes, among other things, requirements regarding the minimum number of native tree species to be reached within a given period of time in restoration projects, and the precise proportion of functional groups or threatened species to be included when reforestation with native species is used as a restoration technique. There are, however, two differing perspectives among Brazilian restoration ecologists on the appropriateness of such detailed legal rules. For some, the rules help increase the chances that mandatory ecological restoration projects will succeed. For the other group, there is no single way to achieve effective ecosystem restoration, and the existing science and knowledge are far from sufficient to establish standardized technical and methodological norms, or to justify that such norms be imposed. Both points of view are discussed here, aiming to help those developing new legislation and improving existing laws about ecological restoration. The precedents established in São Paulo State, and at the federal level in Brazil, and the ongoing debate about them, are worth considering and possibly applying elsewhere.

**Socioeconomic characterization and local perspectives of rural landscape modifications as linkages for economic valuation of forests in natural protected areas**

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Natural resources in the National Park Nevado de Toluca are used by local communities for self-consumption and/or for income generation; however, this socio-economic dependency with the forest has caused an environmental degradation of the area. The growth of population has placed a remarkable pressure in forestry resources; there has been a sharp increase of land for agriculture and grazing, and timber and firewood extraction. With the aim of generating scientific knowledge that can contribute to the restoration and conservation of forestry ecosystems, the current study considers an analysis of socioeconomic variables influencing landscape modifications and local knowledge about the benefits provided by the use of forests. Qualitative research methodologies such as surveys to ‘ejidatarios’ (farmers), interviews to key informants, and participatory workshops were used in the community of Buenavista in order to determine land occupation and residents’ major needs, lifestyle and perspectives of the modification of rural environments. These approaches helped local residents to better understand the objective of the governmental programme of payment for environmental services in natural protected areas. Results showed that landscape is valued the most by local residents due to the economic benefit they obtain by the use of natural resources in the area instead of its scenic beauty or aesthetic value. Residents’ recognition of the value of forest conservation was a main identified local perspective; residents are aware of the significance of protecting and restoring forestry resources in order to access water, a key resource for the development of their agricultural activities.

**Restoring natural capital in agro-ecological and silvicultural systems**

**Asem, Samira Omar**

Kuwait Institute for Scientific Research

Native plants are adapted to the climatic conditions suitable for regenerating ecosystems. An area of 79,000 m² was planted with native seeds collected at different locations in the desert of Kuwait. The farm established facility included: nursery area; shade house area; laboratory area; seed processing room; seed storage room; open field and irrigation by Reverse Osmosis (RO) water with an installed capacity of 375,000 gallons/day. This work resulted in production of 45,000 native plants belonging to 10 species. Keystone species that were grown in large quantities included *Calligonum polygonoides*, *Farsetia aegyptia*, *Panicum turgidum*. Small quantities of the following species were also propagated: *Astragalus sieberi*, *Convolvullus oxyphyllus*, *Helianthemum lippii*, *Lycium shawii*, and *Salvia spinosa*. About 21,000 plants have been planted in the field; a further 24,000 are located in the greenhouse/shade house and can be used directly for restoration/greenery programs. Irrigation water usage was reduced from 50 to 90 %. The project succeeded in standardizing germination and growth requirements of native species; established the production unit with capacity of 1 million seedlings per year. However, major constraints were: labor intensive work; unexpected insect attacks due to various reasons; availability of seeds and planting materials; seasonality; climate decides seed production in nature; climate influences germination and growth and fractional germination.

**Ecological restoration advances and challenges in the Middle East**

**Asem, Samira Omar**

Kuwait Institute for Scientific Research

About 85% of the Middle East lies within the arid zone and is largely rangeland, with an annual average rainfall (100-250 mm) variable both within and across seasons. Ecosystems in the region provide goods and services, such as soil, water, forage, natural heritage, food, medicinal plants, energy, building materials etc. for rural populations. However, natural resources, especially the vegetation cover, are being compromised by human activities, armed conflicts, climate and poverty. The loss of biodiversity and natural resources also impact upon the security of water and soil resources, which threatens both the livelihoods of local communities and the country’s economy. Challenges and threats to sustainable management of the region’s ecosystem, natural resources and heritage include: climate change, livelihoods and wellbeing, limited knowledge and skills, political commitment and availability of resources, institutional capacities, decentralization and good governance. Opportunities for the Middle East to restore ecosystems lie in preserving species’ genetic diversity, propagating native plants, utilizing local knowledge and developing broadscale restoration technologies. Recommendations include: • Conserving the ecological, and genetic diversity of species. • Developing restoration strategies that are resilient to climate change. • Improving management of, and access to water resources. • Mainstreaming environmental concerns in business planning and management, raising public awareness, and strengthening private sector cooperation to mitigate the negative impacts of their activities on ecosystems. • Identifying solutions for degraded ecosystems by working with stakeholders and local communities whose ownership and responsibility of natural resources is essential to the viability and sustainability of these solutions.
Lineamientos para la conservación, restauración y uso sostenible de los bosques de roble (Quercus humboldtii) en Corredor de Conservación Guantiva-La Rusia-Iguaque

Avella Muñoz, Andrés; J. Orlando Rangel-Ch
Fundación Natura, Colombia

Los bosques de roble (Quercus humboldtii H.B.K.) constituyen el esqueleto de varios ecosistemas representativos del ambiente montañoso colombiano. A partir del diagnóstico regional, la definición de los tipos de robleales, la inclusión de visiones de las comunidades locales y la integración de enfoques de gestión ecosistémica, se formuló un conjunto de lineamientos para la conservación y el uso sostenible de los bosques de roble del sector central del corredor de conservación Guantiva-La Rusia-Iguaque. Se identificaron siete tipos de bosques de roble los cuales se agrupan bajo la gran formación de Quercus humboldtii y Billia rosea. En la franja altoandina (>3100m) se encuentran los bosques de Q. humboldtii y Ocotea calophylla, en la región andina (2100-3100 m) se establece la formación de Q. humboldtii y Alchornea grandiflora la cual incluye cuatro tipos de bosques, en la región de vida subandina (1000-2100 m) se establecen los bosques de Virola macrocarpa y Q. humboldtii. Así mismo se presentan las semejanzas que existen con otros bosques de roble de Colombia. Los lineamientos propuestos se estructuraron a partir de siete criterios: marco jurídico e institucional; conservación de la biodiversidad, integridad ecológica, conservación de suelos y recursos hídricos; sostenibilidad de la oferta de productos forestales; incorporación de visiones y prácticas de manejo desde la perspectiva cultural; incorporación de propuestas socioeconómicas para el mejoramiento de la calidad de vida.

Restauración del paisaje forestal en El Corredor de Conservación Guantiva-La Rusia-Iguaque.

Estudio de caso: Cuenca del Río Guacha. Departamento de Santander, Colombia

Avella Muñoz, Andrés; Clara Solano, Selene Torres, Fernando Díaz, América Melo, Luis Mario Cárdenas
Fundación Natura, Colombia

Entre los bosques andinos más representativos de Colombia se encuentran los bosques de roble (Quercus humboldtii H.B.K.), los cuales tienen alta importancia biológica y socioeconómica. En la Cuenca del río Guacha ubicada en el corredor de conservación Guantiva-La Rusia -Iguaque (Santander, Colombia) se diseñó una estrategia de restauración a escala de paisaje con el fin de mejorar y recuperar en el largo plazo la integridad ecológica de los bosques de roble y de aportar al bienestar de las comunidades locales. El trabajo abordó dos fases concertadas con las comunidades; en la primera se realizó un diagnóstico regional y en la segunda se formuló la estrategia de restauración. Se identificaron en éstos ecosistemas los procesos históricos y actuales de degradación, su estado ecológico actual, su potencial de regeneración natural y se definió el ecosistema de referencia. En la estrategia de restauración se implementó un programa de propagación de quince especies nativas a través de viveros comunitarios, se han protegido 1600 ha de robleales mediante acuerdos de conservación privada, se implementó una estrategia de rehabilitación de áreas forestales degradadas mediante el establecimiento de 20 ha de bosques multipropósito y 130 ha de sistemas silvopastoriles. Finalmente, se está implementando tratamientos silviculturales en 200 ha de bosques intervenidos para reactivar los mecanismos de regeneración y viabilizar la reintroducción de especies nativas, y un sistema de monitoreo como estrategia de manejo adaptativo.

Plantes nodrizas y proceso de restauración del Bosque Mesófilo de Montaña

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El nodricismo es un proceso clave en la dinámica de varias comunidades vegetales y actualmente se reconoce su relevancia en el campo de la restauración debido al potencial que representa para recuperar ambientes degradados. La fragmentación del bosque mesófilo de montaña (BMM) requiere del desarrollo de estrategias que mitiguen este problema. Especies arbóreas pioneras, como Alnus acuminata y Trema micrantha, tienen un crecimiento rápido y generan condiciones de sombra, lo cual modifica las condiciones microambientales. La utilización de árboles pioneros como nodrizas puede facilitar el establecimiento de especies de estados sucesionales intermedios o avanzados del BMM como Juglans pyriflormis, Quercus insignis y Oreomunnea mexicana. Estas tres especies presentan alguna categoría de riesgo, lo cual las hace más vulnerables y las convierte en candidatas para ser utilizadas en programas de restauración y conservación. Esta investigación evalúa la capacidad de Alnus acuminata y Trema micrantha como plantas nodrizas de J. pyriflormis, Q. insignis y O. mexicana. Los resultados preliminares indican que Alnus acuminata tiene un efecto positivo sobre la supervivencia de estas tres especies. Por su parte,
Trena micrantha muestra un efecto menos claro respecto a la supervivencia de J. pyriformis, Q. insignis y O. mexicana en comparación con el sitio abierto. Las plantas nodriza son una opción viable para facilitar el establecimiento de especies primarias en el contexto de las acciones de restauración del bosque mesófilo de montaña.

Restauración ecológica a través de núcleos de regeneración dentro de plantaciones forestales exóticas de Pinus patula y Cupressus lusitanica

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Al interior de claros abiertos dentro de plantaciones forestales exóticas se desarrolla un proceso de restauración ecológica del bosque altoandino a través de núcleos de regeneración que incluyen matrizes de leguminosas herbáceas y especies leñosas de diferentes estadios sucesionales. Esta investigación se lleva a cabo en una plantación de Pinus patula y Cupressus lusitanica ubicada en el Embalse de Chisas, zona rural de Bogotá. Se establecieron matrizes de Lupinus bogotensis y Lupinus mirabilis combinadas con 3 especies leñosas pioneras de rápido crecimiento (Verbena crassireama, Smallanthus pyramidalis y Solanum oblongifolium) y 6 especies leñosas de crecimiento lento (Citharexylum subflavescens, Viburnum trypillum, Valea stipularis, Weinmannia microphylla y Oreopanax floribundum). El uso de especies con atributos funcionales complementarios permitió acelerar el proceso de restauración, pero el factor determinante, especialmente en las etapas iniciales del proceso, fueron las condiciones ambientales de los claros donde se ubicaron las parcelas. Los claros grandes, con más cantidad de horas luz y suelos ricos en Ca y P, maximizan el crecimiento de todas las especies. Actualmente, los núcleos de restauración, presentan una marcada estratificación por coberturas, lo cual indica que la estructura del área restaurada, es cada vez más parecida a la del ecosistema de referencia. La estrategia de núcleos se muestra más efectiva que las siembras abiertas porque se generan condiciones más favorables para el crecimiento y persistencia de las especies de interés.

Evaluation of the Joumine marsh restoration, Ichkeul National Park, Tunisia

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The creation of Ichkeul National Park in 1980 and its inclusion as a Ramsar (1980) and World Heritage site (1979) as well as a biosphere Reserve (1977) was followed by the construction of three dams on its major wadis (temporary rivers), the drainage of the lower floodplain, the operation of the sluice between lake Ichkeul and lake Bizerte to safeguard a minimum level of the carrying capacity for wintering waterfowl (mean number 200,000 birds before mid-1980s). The implementation of hydraulic infrastructure caused major changes in water quality and aquatic vegetation of the lake and its marshes. The presentation introduces management plans to restore the marsh and discuss why there were only limited impacts within the context of climatic conditions (successive spells of drought, floods, and years of mean rainfall) and grazing pressure. Also, the latest floods of 2003-2004 are highlighted after noticing some positive signs of re-growth of Scirpus maritimus but unfortunately this exceptional event was not followed by a proper study. The presentation focuses on a critical retrospective evaluation (over more than 30 years) of this experience of restoration in respect to conflicts between stakeholders at several level of decision making process on one hand and the administration and local people on the other. At the end a tentative proposal is made to suggest measures that may constitute guidance for best practice in the case of this main habitat of the internationally important wetland at Ichkeul.

Quantifying and valuing ecosystem services: A “state of the science” tools review

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US Geological Survey

Ecosystem services are increasingly advocated as a framework to support conservation and resource management. In this study, we evaluated emerging ecosystem services assessment tools to assist decision making for the Bureau of Land Management. Our case study site, the San Pedro River in northern Sonora and southeast Arizona, is internationally recognized for its high biodiversity and ecological significance, yet its critical riparian ecosystem is threatened by groundwater pumping. We evaluated ecosystem services identified as important by local stakeholders and scientists – those derived from water, biodiversity, carbon, and cultural values. We identified 18 methods and tools to quantify and value ecosystem services, which are in various stages of development and usability. We evaluated the utility of each approach based on a series of criteria relevant for public land managers, including resource requirements, scalability and generalizability, and the ability to incorporate multiple valuation perspectives (e.g., monetary and non-monetary). Out of these 18 approaches, we used primary valuation, value transfer
(particularly function transfer and the Wildlife Habitat Benefits Estimation Toolkit), and the InVEST and ARIES modeling tools to quantify and value these services. A parallel effort to explore ecosystem services tools for private sector environmental management, led by BSR (formerly Businesses for Social Responsibility) also evaluated the EcoMetrix, EcoAIM, ESVvalue, NAIS, and ESR tools for the same project site. Results of this work quantitatively demonstrate tradeoffs in ecosystem service provision under current conditions and alternative management scenarios. They also highlight the strengths and weaknesses of alternative assessment methods in different resource management settings.

The greener side of REDD: Lessons for REDD+ from countries where forest area is increasing

Rights and Resources Initiative, USA

In the last decade, countries have committed major resources to reducing carbon emissions from deforestation and forest degradation in developing countries (REDD). A debate continues on how REDD financing should include related activities, such as the enhancement of carbon stocks through afforestation, reforestation and rehabilitation of degraded lands. Meanwhile, several countries have added to their net forest area with little fanfare or donor funding. This paper assesses the factors that underpin the transition from net defencers to net forest growers in China, South Korea, Vietnam, India and Chile. We review the literature on forest policy processes and government-led reforestation and restoration programs, and find their success relied on government support at the highest levels, and forest governance reforms (particularly land and resource tenure systems) to incentivize good forest management and tree-planting. However, constraints to wood supply have caused some countries to rely on wood imports and “export” deforestation, diminishing global carbon benefits. We argue that the experiences of these reforesting countries carry implications for current REDD countries. Reforestation programs appear to have a clearer benefit for the rural poor in forest areas than REDD programs. However, both depend on improvements to forest governance and forest tenure. Major reforestation activities must be included to effectively confront leakage and additionality issues inherent in REDD. In sum, while debates on REDD implementation continue at the international level, we conclude that improving forest stocks is a necessary complement to successful REDD and recommend that national policymakers focus efforts on these activities.

An assessment of introductory restoration ecology courses in the USA and Canada

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Many restoration ecologists are trained through the post-secondary educational system. Understanding the range and depth of this training may become more important as SER prepares to certify restoration practitioners. Introductory courses in restoration ecology/ecological restoration are an important entry point that can affect student perceptions about restoration ecology and their consideration of it as a potential career. I surveyed introductory restoration ecology courses from 67 post-secondary institutions throughout the United States and Canada. Comparisons were made based on institutional course catalogs and course syllabi. Most courses were offered at Doctoral/Research universities, though some were offered at Master’s, Bachelor’s, and Associate-level institutions. Courses were usually offered through departments with a natural resource management focus, and were usually required or optional in a degree program. Courses were generally aimed at upper-level undergraduate students or graduate students; most required ecology as a prerequisite. Course titles suggested an emphasis on science (restoration ecology) over practice (ecological restoration). This emphasis on science was also reflected in learning objectives, which focused primarily on concepts and less on skills and attitudes. Conventional pedagogical techniques dominated courses: courses were usually taught in classroom settings during the academic year and assessed via exams. The results of this survey provide a snapshot of the current status of restoration education in the United States and Canada. They are relevant to considerations of how to certify restoration practitioners, particularly when combined with broader curricular analyses of restoration programs.

Using multivariate control charts to communicate long-term changes in community composition

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Restoration activities alter the spatial and temporal dynamics of plant communities by introducing desired species to a site and/or removing undesired species. However, these compositional changes are difficult to visualize over time; examining a large number of individual species may not be effective, efficient, or informative. Multivariate control
charts (MCCs) provide a simple method for visualizing compositional changes by simultaneously quantifying changes in the abundance of all species. Changes can be evaluated relative to several criteria. For example, restoration effectiveness can be assessed by examining movement toward a desired plant community. Responses to episodic and chronic disturbances, respectively, can be assessed by examining change relative to initial vegetation composition or to a moving average of prior compositions. We demonstrate this method using an array of vegetation monitoring plots spanning almost 20 years and located on and around the Arid Lands Ecology Reserve in central Washington, USA. This area contained a large expanse of sagebrush-dominated habitat, but has experienced significant impacts from wildfires and invasion by exotic annuals. Significant investments have been made in restoration treatments such as herbicide application, native seeding, and out-planting of Wyoming big sagebrush (Artemisia tridentata wyomingensis). Plots span a wide range of environmental conditions, fire frequencies, and restoration actions. Plots that experienced more frequent fires showed the greatest change in composition. Communities dominated by resprouting species showed the least change in composition. MCCs are a promising way for managers to track the impacts of restoration and of disturbances.

**Red Iberoamericana y Del Caribe sobre Restauración Ecológica-RIACRE**

*Balensiefer, Mauricio; Fernando Bustos*

Sociedade Brasileira de Recuperação de Áreas Degradadas

La Red Iberoamericana y del Caribe sobre Restauración Ecológica-RIACRE, creada en Cuba en 2007 es una alianza científica de ambientalistas con enfoque en la restauración ecológica independiente, voluntaria, abierta, participativa e internacional, cuyo campo de actuación son los países iberoamericanos y del Caribe. Su objetivo es promover la integración de técnicos, científicos, profesionales, ambientalistas, gestores de recursos naturales y de personas e instituciones afines al tema. A RIACRE pretende desarrollar y establecer marcos teóricos, metodológicos y prácticos para la mención de la recuperación ecológica, los cuales correspondan al contexto ambiental, económico, político y social aplicables a los diferentes países de esta región. Forman parte de sus acciones la capacitación, compartir conocimiento, investigación, realización de cursos y congresos, difusión de técnicas pertinentes y relevantes al tema, la promoción de vínculos científicos entre los investigadores, restauradores y ambientalistas en al ámbito internacional y la realización de campañas locales para formar la conciencia de recuperación ambiental. Permanecerá como una entidad técnica y científica sin ningún objetivo económico/lucrativo y evitando cualquier tipo de publicidad política, partidaria, ideológica e filosófica. Sus integrantes pueden ser redes regionales y locales de países que la constituyan, asociaciones, grupos y asociados individuales. Sus estatutos disponen de dispositivos que alcanzan los derechos y obligaciones de los participantem, organización, funciones, redes asociadas, reuniones y convenciones, reforma y alteración de estatutos y demás reglamentos que podrán viabilizar sus objetivos y contribuir en el atendimiento a las demandas temáticas en la región de actuación.

**Adopting ecological restoration: A challenge for surface mining in Brazil**

*Balensiefer, Mauricio; James Jackson Griffith*

Sociedade Brasileira de Recuperação de Áreas Degradadas

Rehabilitation as practiced today at Brazilian surface mines is quite advanced. Intense efforts that began in the latter part of the 1970s have resulted in substantial technical and institutional progress. Yet this development has been somewhat insular from international trends. Virtually no companies in Brazil’s mineral sector have publicly declared that they have adopted, or intend to adopt, practices based on either the SER International Primer on Ecological Restoration or the SER Guidelines for Developing and Managing Ecological Restoration Projects. This is in contrast to a recent worldwide upsurge in ecological restoration with well-documented examples in mining. Some Brazilian mines may make limited use of parts of the principles or guidelines, but these initiatives fall short of full-fledged deployment. This presentation focuses on: 1) describing possible motives that might explain hesitation by mining firms in Brazil to fully commit themselves to ecological restoration, 2) discussing two challenges that may be obstructing such a commitment (a legislative barrier and an ecological challenge), and 3) pointing out the advantages to be gained if the mining sector were to adopt the SER directives. The presentation analyzes two contrasting examples of surface mining in Brazil: 1) excavation of oil shale of the Irati formation in Paraná State and 2) iron-ore mining in the Quadrilátero Ferrífero region of Minas Gerais State. The results of this analysis should give cause for mining rehabilitation specialists in Brazil and elsewhere to consider full adoption of the SER principles and project guidelines.
Towards a carbon neutral ecotourism: Analysis of alternative management regimes for the Chocolate Hills Natural Park of Bohol, Philippines

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University of the Philippines, Los Laguna

This study sought to find an alternative management scheme for the Chocolate Hills Natural Monument (CHNM) in Bohol, Philippines. The current practice involved clearing of hills around the vicinity of the view complex to ensure a tree-less hilly landscape. This scheme is seen as environmentally unsound and violates existing laws. Due to the implementation of laws, the area is exhibiting signs of natural regeneration leading to a forested landscape which, according to the ecotourism managers, is drawing away the tourists. We tried to look for a carbon offset program for the park and ecotourism managers. We undertook assessments of the biophysical, carbon stocks and socio-economic features of the park. We proposed a scheme where some 300 hills would be cleared of vegetation up to 80% from the top and leave 20% vegetated reckoned from the bottom. The result of the carbon study was to show that this scheme can be justified by establishing one hectare of forest for every two hills cleared. As such, to clear 300 hills for tourism purposes, a corresponding minimum of 150 ha of forest needs to be established. Comparing the carbon density of hills with different cover, results show that carbon density of hills with 100% trees (74.34 t/ha) do not differ much with the carbon density value of hills with 20% trees (68.32 t/ha). The scheme provides a win-win situation for the park and ecotourism managers. A draft resolution for the park managers has been submitted to initiate a carbon offset program.

Comparison of bird diversity in restored tropical forests

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Secondary forests, reclaiming one sixth of deforested land worldwide, play a vital role in biodiversity conservation, and growth of ecological restoration science suggests the need to examine treatment methods. In this study, birds were surveyed in three sites of varying restoration treatments in moist tropical forest in the Ecuadorian Amazon. The first site was a manually restored and rehabilitated secondary forest thirty years in age, having witnessed extensive inputs of organic fertilizers, planted species, and manual labor. This site was compared with two nearby secondary forests of similar size, structure, and age, only with the difference of having undergone a natural reforestation without fertilization nor planted species. Approximately ten days of point counts and mist net monitoring were performed in each site. Results indicate the degree of variation of species richness and composition between sites of distinct restoration treatments, offering clues on the impact of high-investment manual restoration.

Effect of biosolids in the restoration of soils affected by opencast mining in highland forests of Bogotá (Colombia)

Barrera Cataño, José Ignacio; Pilar Andrés
Pontificia Universidad Javeriana, Colombia

In response to the destruction of land for mining activity in the high Andean ecosystems near Bogotá and the high production of biosolids from Plan Wastewater Treatment Salitre and the difficulty involved in final disposal, research was carried out to assess the effect of biosolids amendment over the restoration of areas that have lost the organic soil layer after being used for mining. Indicators used were the vegetation and soil macroinvertebrate community in the early stages of succession. A randomized design was proposed with three treatments, three sterile-biosolids mixtures at three proportions V/V: (T1) 8:1, (T2) 4:1, (T3) 2:1, and a control (C). Coverage, richness and species diversity of vegetation and macrofauna were monitored quarterly. In the case of macrofauna, density was also monitored. The effect of mixtures of these variables was performed using the MIXED procedure for repeated measures (SAS 2002). It was evident that the application of biosolids corrected some existing limitations in the sterile soil and promoted the colonization of these substrates by soil macrofauna and vegetation, mainly medium doses.

Priorities for ecological restoration of soil and its associated ecosystem services degraded by agricultural use in the watershed Santa Helena (Suesca, Cundinamarca, Colombia)

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The watershed Santa Helena is an example of the Andean forest with farming overuse leading to declining and loss of ecological services from the soil, which threatens the food security of the communities unless recovery actions are performed. The aim was to identify priorities for ecological restoration (ER) of soil and its associated ecosystem services. The level of soil conservation to provide environmental services and Economic Evaluations Properties (EEP) were considered. The priority of restoring of the soil was calculated. Four levels were considered for the conservation of ecological services, 10.91% of the watershed area had levels of conservation (LCS) very low, 54.57% had LCS medium and 21.73% had LCS high. Eighteen of the 43 landscape units (LU) selected had a low qualification and eight had a high qualification. The LU with very low and low LCS, and with low EEP had high priority of ER, while the LU with both high LCS and EEP had low priority of ER.

**Andean tropical forest restoration affected by invasion of Ulex europaeus L.**

*Barrera Cataño, José Ignacio; Carlos Miquel Riba, Eduardo Alonso Felipe Rios, Pilar Andrés Pastor*

Pontificia Universidad Javeriana, Colombia

*Ulex europaeus* (Fabaceae) is considered one of the 100 most aggressive invasive species on the planet, affecting the diversity of the Andean forests of Bogota (Colombia). We carried out a research project at the lowest level of ‘Cerro de Monserrate’ (4°36’38"N, 74°03’54"W), invaded by this species. The effect of manual and repeated removal of seedlings and the effect of plantation of two native species as a control strategy were evaluated. We performed a two-way factorial design, with three and four levels. Twelve treatments and five replicates were used. The eliminations were doing quarterly and bi-annually per one year. Monitoring was done quarterly for 18 months. In each sampling, floristic inventories were carried out on six permanent transects. Each transect was five meters long and was divided into 20 segments of 25 cm long, for a total of 120 segments per plot. The abundance, richness and Shannon diversity Index were calculated. The effect of the removal of seedlings on the recruitment of *U. europaeus* in both specific richness and diversity, were calculated using the mixed procedure of SAS for repeated measures (SAS Institute - 2002). Effect’s plantations over in the recruitment of *U. europaeus*, richness and species diversity were not identified. Elimination showed effect on recruitment (P<0.0001) and richness (P<0.0432) but not on the Shannon diversity Index (0.0901).

**Ecological restoration school, a space for training of news researches and restorers in Colombia**

*Barrera Cataño, José Ignacio; Sandra Contreras-Rodríguez, Mauricio Aguilar-Garavito*

Pontificia Universidad Javeriana, Colombia

The Restoration Ecology School (RES) is a space created by teachers, students and professionals of the Pontificia Javeriana University dedicated to develop both ecological restoration and restoration ecology subjects in Colombia. Since its beginning (2002), its aim was strength the theoretical and practical views about restoration ecology and ecological restoration, by means of activities as learning, reflection, discussion and practice. The RES has a conceptual framework based on continuous feedback from the theory and practice, defining disturbance typologies as an ecological restoration approach. The RES set up the Colombian of Ecological Restoration Network and it organized scientific meetings such as the I Colombian Symposium on Ecological Restoration Experiences, International Course of Urban Ecology, the I International Course of Ecological the Restoration of Quarries and Biosolids Use and Second International Course of Ecological Restoration of Areas Affected by Surface Mining. Along with governmental and non-governmental institutions, the RES has conducted research, consulting, consultancy and evaluation and monitoring of ecological restoration projects. It also has various publications with theoretical and practical tools for ecological restoration as the “Manual for Ecological Restoration of disturbed ecosystems of the Distrito Capital” (2010), it formulated the basic document of the Distrito Capital of Ecological Restoration 2010-2038, and supported the formulation of the National Plan for Ecological Restoration. It created his own website (www.erecolombia.com) to communicate national and internationally with colleagues and partners.

**Colombian Ecological Restoration Network as a strategy for the growth of the issue in Colombia**

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Pontificia Universidad Javeriana, Colombia

Formation of networks is an increasingly urgent need for the exchange of experiences and knowledge about specific topics, such as ecological restoration and restoration ecology. The Colombian Ecological Restoration Network (CERN) was an initiative of the School of Ecological Restoration (SRE) of the Javeriana University emerged in the I International Symposium on Ecological Restoration in Cuba (November 2004), in order to provide a space for communication, discussion and cooperation for those interested in the subject. Since its creation in 2006, the CNER...
distributed of the Bulletin and organized in 2007 the First National Symposium on Ecological Restoration Experiences in which formalized the CNER and held its first Assembly. The coordination was delegated in 2007, for a period of two years, to the Group of Ecological Restoration of the National University of Colombia who organized the First Colombian Conference of Ecological Restoration. Currently, the CNER is a non-formal and non-profit organization, integrated by both individuals and representatives of educational institutions, state institutes of the National Environmental System and non-governmental organizations interested in ecological restoration and restoration ecology. It has 827 members, has produced 11 newsletters and has a web page as a means of mass distribution (www.redcre.org). The aim for the coming years is to strengthen it through commitment and work of its members.

Proceso de restauración ecológica en plantaciones de Eucalyptus globulus – cerros orientales borde urbano, Bogotá, Colombia
Barrera Velásquez, Germán Eduardo; Claudia Alexandra Pinzón, Héctor Felipe Ríos
Jardín Botánico de Bogotá, Colombia

Los Cerros Orientales de Bogotá son el patrimonio ambiental y cultural más importante de la ciudad. Desde la conquista española hasta el actual desarrollo de la ciudad; han sufrido deterioro ecológico debido a la deforestación, minería y posterior reforestación con especies forestales exóticas e invasión de especies introducidas, generándose el deterioro acelerado de las condiciones ambientales de los ecosistemas de Bosque Altoandino y Paramo. Esta situación se convierte en un tema trascendental en la agenda ambiental y política de la ciudad. Actualmente los Cerros Orientales están declarados como zona de reserva forestal nacional. A través del Plan de Desarrollo de Bogotá 2008-2012, El Jardín Botánico de Bogotá tiene como meta adelantar el proceso de restauración ecológica de 400 hectáreas, para lo cual cuenta con COP$ 10.500.000.000 (USD$ 5 millones), que se ejecutan a través de la Subdirección Científica en el equipo de Restauración Ecológica. En el marco de este proyecto se adelantó el estudio de caso San Dionisio, el objetivo de la presentación es dar a conocer los resultados de caracterización, implementación, participación comunitaria y evaluación y seguimiento. En San Dionisio se adelantó el proceso de restauración ecológica para 34.5 Ha, se estableció el potencial de restauración como herramienta de planificación, se reintrodujeron 8.900 individuos de 36 especies vegetales nativas, con una sobre vivencia del 97%, y se vincularon alrededor de 350 personas de instituciones educativas y comunitarias. Estas acciones se consolidan como una gestión importante para recuperar, proteger y conservar los Cerros Orientales de la ciudad.

Urban parks vegetation and its contribution to biodiversity conservation in Heredia, Costa Rica
Barrientos, Zaidett; Maribel Zúñiga, Gabriela Pérez, Ana Varela
Universidad Estatal a Distancia, San José, Costa Rica

Transformation of native ecosystems in Costa Rican urban areas has been so great that practically the only remnants are those areas protected by law, especially 10 meter strips along each river bank. These strips have become biological corridors that cross the Great Metropolitan Area (GAM) and connect urban parks. We studied the species composition and abundance of flora (≥ 5 cm DBH) in 35 urban parks in Heredia (GAM) and 24 segments of Río Segundo, a river that flows through this area. We also studied the change in land use in the Río Segundo protected area. We found that introduced species dominate in 70% of the parks, 10% had only introduced species and 5% had native species only. The dominance of some species in the parks is notorious. By contrast, in the river margins diversity is higher, most species are native and none is dominant. In Río Segundo, 23% of the area is not covered by natural vegetation, despite its legal protection. Education is needed to make citizens, as well as politicians, aware of the importance of protecting these areas and of improving urban park management, which should have social and environmental functions. However, botanical data from river margins should be analyzed with caution due to the temporary abundance of pioneer species, product of the river’s normal dynamics. New legislation for the protection of larger areas of the riverbanks should be promoted. Ecological restoration of tropical urban environments should consider native species composition and abundance.

Dynamics of leaf-litter moisture, depth and amount: Two widely applied restoration techniques failed to reproduce the ground microhabitat conditions of a cloud forest in Costa Rica
Barrientos, Zaidett
Universidad Estatal a Distancia, San José, Costa Rica

Leaf litter helps stabilize moisture, is part of the nutrient cycle and serves as habitat for many organisms. Nevertheless, little is known about how restoration techniques affect aspects like leaf litter amount, depth and
moisture. I analyzed their general patterns in a primary cloud tropical forest and two areas with restoration techniques widely applied in Costa Rica: a 15 year old secondary forest (natural succession) and a 40 year old *Cupressus lusitanica* plantation (commercial exotic plantation with understory left to natural succession). Twenty litter samples were taken every three months (April 2009 to April 2010) in each habitat; moisture was measured in 439 g samples, depth and amount were measured in five points inside 50x 50cm plots. None of the restoration techniques reproduced the primary forest leaf litter humidity, depth and amount patterns along the year. Primary forest leaf litter moisture was higher and more stable. Litter accumulation is higher in the primary forest during April due to the strong winds. In the plantation, *C. lusitanica* does not lose its leaves despite the strong winds. Litter depth is shallow in October because the heavy rains compact it. The secondary forest does not show this pattern: the ground is still covered mainly with grass. Future studies should evaluate other restoration techniques (e.g. native species plantations) and the effect of longer periods.


Battaglia, Loretta; Hannah Kalk
Southern Illinois University, USA

Coastal ecosystems are among the first directly impacted by climate change. Sea level rise and hurricane disturbances, respectively, are projected to increase and intensify along the northern Gulf of Mexico. Coastal species whose ranges are limited by suitable establishment sites or dispersal are likely to decline and eventually become locally extirpated under rapid environmental change. Species occupying the seaward end of coastal gradients may be capable of establishing landward with the removal of biological filters consistent with hurricane disturbance. In August 2008, we established a reciprocal transplant experiment at Weeks Bay, Alabama, USA. Fifteen 1m² plots were established in each of five vegetation zones: salt marsh, brackish marsh, fresh marsh, forest-marsh ecotone, and wetland seep forest. To simulate the removal of biological filters, all standing vegetation was removed from each plot. Following vegetation removal, each plot was planted with five culms of one of three dominant species (n=5 plots per species per zone): *Spartina alterniflora* (salt marsh), *Juncus roemerianus* (brackish marsh), or *Cladium mariscus* (fresh marsh). All species successfully re-established in their own zones, but none established in more seaward locations. Spartina did not survive in more landward locations. Juncus and Cladium established and grew in all zones landward of their original zones. Our results suggest that assisted colonization of less halophytic coastal species into successively landward zones, and thus anticipatory restoration, may be feasible when biological filters are relaxed.

**Evaluation of restoration – learning from science and people to improve restoration practice**

Bautista, Susana
University of Alicante, Spain

There is a consensus on the need for the evaluation of restoration activities. Evaluation is the key element that links and facilitates feedbacks between the advances in restoration science and technology and the practice of restoration. It is increasingly recognized that evaluation of restoration must consider both biophysical and socio-economic attributes, as well as scientific and local knowledge. The participation of stakeholders also is increasingly demanded. In recent years, significant progress has been made towards developing assessment protocols and guidelines for environmental monitoring and assessment. However, to achieve a more widespread, scientifically sound, and effective evaluation of restoration actions, a number of challenges still need to be addressed, including: the development of protocols and tools for the integration of scientific knowledge and stakeholder perspectives on the restoration outcomes; the selection of a minimum set of evaluation criteria and indicators that allow common, comparative assessments of a wide range of restoration actions; the incorporation of the ‘Ecosystem Services’ concept into the evaluation frameworks; the development of participatory approaches to evaluation; the exploitation of remotely-sensed imagery and spatial analysis techniques; and the incorporation of new communication and dissemination tools into the assessment methods. Finally, a further development of this topic within the SER Primer could greatly contribute to highlight the crucial importance of restoration evaluation and promote its routine implementation within the restoration process.

**Potential for using simple plant-pattern metrics to assess dryland restoration**

Bautista, Susana; Angeles G. Mayor, Anna M. Urreghe, Francisco Rodríguez
University of Alicante, Spain
The use of simple structural indicators that could characterize ecosystem recovery adequately and could be applied to a broad range of sites and project types is a cost-effective approach to restoration assessment. Recently, a variety of plant-pattern metrics have been proposed as general indicators of dryland ecosystem functioning, with more or less potential for early warning on ecosystem state transitions. In this work, we review the scientific support and discuss the potential of using plant-pattern metrics for assessing dryland restoration, and present empirical evidence of the independent role played by plant cover and plant pattern as drivers of hydrological functioning in drylands. Through the manipulation of the plant spatial pattern, restoration activities can greatly change the connectivity of the bare soil matrix (plant inter-patches), with or without major changes in plant cover, which may lead to significant changes in the overall functioning of the restored land. Pattern metrics that capture the connectivity of the bare-soil inter-patches integrate changes in both plant cover and pattern. These metrics are highly correlated to dryland eco-hydrological functioning, showing a great potential for assessing dryland restoration.

**Oyster reefs at risk: Restoring a globally imperiled ecosystem**

**Beck, Michael; Rob Brumbaugh, Boze Hancock, Mark Spalding**

The Nature Conservancy, USA

Oyster reefs are an important coastal habitat type that delivers an array of ecosystem services. Like many other coastal habitats, a variety of stressors have led to declines in both their structure and ecological function. Globally, 85% of oyster reefs have been lost, with a commensurate loss of functionality in scores of estuaries. Fortunately, there are many management and conservation actions that are available to improve and protect the viability of oyster reefs, and these are increasingly being used globally. Co-management approaches show promise in South America and could be used more broadly. In the U.S., oyster reefs are increasingly being restored and managed for the return of other ecosystem services such as water filtration and shoreline protection. Emphasizing these broader ecosystem values within international conservation policies would help propel bivalve conservation and restoration efforts at ecologically meaningful scales. Restoration efforts in the U.S. have expanded dramatically in the past ten years from small scale (< 1 ha) community-based experiments to much larger-scale (10s-100s of ha) projects designed for both job creation and ecological benefits. Now, spatially-explicit decision support tools that can illustrate the tradeoffs and benefits of different restoration project designs are helping to shape decisions for even larger-scale restoration of oyster reefs in places like the Gulf of Mexico, following the Deepwater Horizon oil spill in 2010, and could provide a model for setting restoration objectives in other parts of the world.

**Electrical fields increase coral growth in Tobago**

**Beddoe, Lee Ann; Thomas J. Goreau, John B.R. Agard, Dawn A.T. Phillip**

University of the West Indies, Trinidad and Tobago

Tobago coral reefs are declining with little natural recovery. Field experiments on coral growth with and without direct current electrical fields were conducted in a small protected bay on Tobago. Electrically conductive Buoyancy Test Racks (BTRs) with individual coral fragments, served as cathodes. Forty coral nubbins were attached to electrically charged BTRs and the same number of nubbins attached to BTRs with no electricity acted as controls. The BTRs allowed measurement of growth in weight and volume of individual nubbins via buoyant weighing and water displacement. Growth showed significant differences in mean weights of controls versus charged. During the 48-week time period of the experiment the controls showed a significant decrease in weight of about 50% (ANOVA F=2.46 and P=0.0012). This decrease is exceptional, and was due to very poor water quality at the site. However, during the same time period the charged treatment showed a significant increase in weight by about 400% (ANOVA F=11.54 and P=0.0000). The experiment was conducted in three stages, with power on for the first and third, and off for the second period. Growth of corals on charged BTRs was rapid in periods one and three, but when the current was off they decreased in weight like the controls. Therefore the growth benefits were due to the electrical field. With some methodological adjustments this technology has the potential to restore reefs that are adversely affected by environmental change.

**Plant a billion trees campaign: Promoting large scale restoration in the Atlantic Forest, Brazil**

**Benini, Rubens; Aurélio Padovezi, Ricardo Viani, Nino Amazonas, Luiz Flavio Lima**

The Nature Conservancy, Brazil

Brazil’s Atlantic Forest (AF) is one of the world’s most diverse biomes and has been reduced to 12% of its original size. A major restoration initiative is vital to improving the ecological function of the AF. The Plant a Billion Trees (PBT) Campaign has taken a science-based approach to defining priority areas to be restored in the AF, identified
degraded areas within the restoration priorities, engaged landowners, local NGOs, universities and different levels of governments in order to enable restoration initiatives on those degraded areas. Since launching the PBT Campaign in 2008, The Nature Conservancy has restored 2,643,64 ha of degraded areas on 664 properties in six Brazilian States, representing more than 6,6 million native trees. 130 farmers, rural workers, and restoration practitioners were also trained in restoration techniques. Three main restoration techniques are being used to jumpstart natural processes: a) native tree seedlings planting; b) enrichment; c) assist natural regeneration. PBT has also helped several Brazilian states to establish state-wide payment for environmental services programs. Every restored area is monitored for four years. Ecological indicators are measured to assure that degraded areas are successfully evolving into forests. An online system to track individual donations to their final result on the ground provides greater financial transparency. The goal of this work is to establish the basis for a large scale restoration initiative in Atlantic Forest, creating jobs, protecting critical watersheds, sequestering atmospheric carbon, and building awareness of the relationship between humans and our environment.

**Oyster Growth Study using Biorock® Accretion Technology**

Berger, Nikola; Mara Haseljine, J. T. Boehm, Thomas J. Goreau

City University New York, USA

Oyster growth and survival were followed for two years in populations of *Crassostrea virginica* grown in continuous flow-through tanks with and without Biorock direct current electrical stimulation, using bottom water pumped from the Hudson River next to mid-town Manhattan. Oysters exposed to the electrical current grew significantly faster than controls and had higher survival. Growth rates of electrically stimulated oysters were 2.75 and 1.62 times faster in length than controls in 2007 and in 2008 respectively, while mortality rates of un-charged control oysters were 2.08 and 1.36 times higher than those receiving electrical current. An increase in linear growth rate of 2 implies an 8 fold increase in weight. These results suggest that oyster reefs can be rapidly restored using Biorock electrical stimulation, through increased growth rates and higher survival from environmental stress episodes. Two hundred years ago New York City had 350 square miles (906.5 sq km) of oyster reefs, but now has effectively zero, with consequent loss of filtration and maintenance of marine water quality. Restoration of oyster reef and saltmarsh habitat is now being promoted by New York’s Green Infrastructure Program, to reduce expenditures for drinking water and sewage treatment. Use of Biorock methods on a large-scale could bring back the oyster reefs with the fastest possible growth and survival.

**Selección de plantas para el control de la erosión en taludes por medio de la metodología de criterio de expertos, Costa Rica**

Bermúdez, Tania; Virginia Álvareza García, Lilliana Piedra Castro, Marilyn Romero Vargas

Universidad Nacional, Costa Rica

Los taludes aumentan la erosión, los deslizamientos, la pérdida de biodiversidad, y la sedimentación. El establecimiento de coberturas vegetales constituye una práctica fácil y positiva de restauración de los taludes, por su baja inversión y por ser una alternativa eficiente en la conservación del suelo. Sin embargo, la restauración ha sido con plantas introducidas, el conocimiento sobre la utilidad de plantas es empírico y no documentado apropiadamente. Se utilizó la metodología de criterio de experto para documentar cuales plantas pueden ser utilizadas en la restauración de taludes. Se realizaron 20 entrevistas a expertos de las áreas de la botánica, agronomía e ingeniería. Se preguntó cuales plantas son utilizadas para la restauración de taludes, el nivel de importancia (categorización) y el porqué. Los expertos recomendaron un promedio de 5 plantas. Se obtuvo 73 especies de las cuales 58 % son nativas y 42 %, exóticas. Se realizó un análisis de correspondencia simple (ACs) del nivel de importancia de las especies citadas por los expertos con respecto a su frecuencia de concordancia de categorización. El ACs no evidencio una clara separación de los primeros tres niveles de importancia; los niveles 4 y 5 quedaron muy separados de los primeros tres. No hay una especie predilecta por los expertos sino varias. Las especies más nombradas fueron *Yucca guatemalensis* con 70%, seguido por *Arachis pintoi* con 50% y por ultimo *Vetiveria zizanioides* 25%.

**Using biota and soil transplantation to restore species rich grasslands on former arable land**

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Netherlands Institute of Ecology, Wageningen

A common practice in Europe is the restoration of species-rich grassland on former arable land. At the on-set of restoration, soil fertility is high, and traditionally the focus in many of these restoration projects has been on reducing soil fertility as a tool to increase biodiversity. However, restoration is often not successful and it can take many...
decades or even centuries before a target plant community has successfully established. We argue that such restoration projects can greatly benefit from incorporating soil biotic interactions in restoration management schemes rather than focusing on abiotic conditions alone. Soil biota are important drivers of plant community composition and succession and the composition of the soil biotic community can be of great importance for vegetation succession and hence restoration success. We will present data from a number of controlled and natural-field experiments in restoration areas to show how plants influence the soil biotic community in their rhizosphere, and how this can subsequently affect other plants of the same and different species. We will also show how introductions of soil organisms and soil communities can affect competition between plants and plant community development and succession, and how this can affect the success of restoration. Finally, we will present the first results of a unique large scale restoration project in the Netherlands where soil manipulations and introduction of soil communities and sods collected from a late-successional grassland have been applied at the onset of restoration as a tool to improve restoration success.

Development of a classification system for the rehabilitation status of asbestos mines in South Africa

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North-West University, South Africa

Asbestos mining has left a legacy of pollution in former mining areas that continues to affect local communities. In 2007 the Rehabilitation Prioritization Index (RPI) was developed as a scientific tool to indicate the preferred sequence for rehabilitation based on the risk assessment for each site. This served as the point of departure for the present investigation in which a database for the rehabilitation success of asbestos sites was developed. Quantitative and qualitative data were analyzed using multivariate statistics, specifically a redundancy analysis, and the most representative model selected for the classification of sites. The multivariate analysis also revealed factors associated with rehabilitation success or failure, as well as essentials to be addressed. The feasibility of development of a rule set for site classification was first investigated using neural networks which also assisted in the selection of significant parameters. Results from the neural network approach were then used to guide parameter selection for the evolutionary algorithm software. The coordinate scores for the first two axes of the redundancy analysis served as targets for the evolutionary algorithms. Overall a targeting match of 71% for the first axis coordinates and 38% for the second axis coordinates were obtained. Contributing parameters for the rule set included: Cl, K, pH, percent organic carbon, Zn, NH₄ and SO₄ content of the sites.

The Mixteca Alta (Oaxaca, Mexico) ARIDnet case study: Applying the DDP to assess the biophysical, socioeconomic and organizational drivers of land degradation and restoration potential

Blauert, Jutta; Heidi Asbjornson
IDEAS Comunitarias, México

The Mixteca Alta is a mountainous region in the southeastern Mexican State of Oaxaca. A long history of over-grazing by goats and sheep under transhumance management, combined with other land use activities, has resulted in severe land degradation. Over the past 25 years a local farmer group, ‘CEDICAM’, has worked with resident communities to mitigate and reverse this degradation. CEDICAM applies an integrated model to restore degraded lands, which involves strengthening initiatives by community actors and social institutions of local communities to enable them to efficiently manage their natural resources to achieve sustainable livelihoods. The paper reports on findings from interdisciplinary research and of an ARIDnet workshop in partnership with CEDICAM and local stakeholders to assess drivers of land degradation in this region and for restoration processes. We explore whether interventions in soil conservation and reforestation by CEDICAM have been successful in achieving significant progress towards reversing the processes of desertification and consolidating community-based initiatives of restoration thereby improving social capital and environmental quality, particularly related to water supply, agricultural production and food security. One of the key methodological axis used is the DDP (Dahlem Development Paradigm) to evaluate perceptions and needs of local communities, and to identify key ecological and socio-economic drivers of desertification and restoration. Two models evolved: one provided a historical depiction of the dominant drivers—and their interactions—while the second provided a framework for restoring degraded lands based largely on CEDICAM’s model.
**Restoration of tropical dry forests in Mexico: What do we know?**

Bonfil, Consuelo  
Universidad Nacional Autónoma de México

Ecological research on Mexican tropical dry forests (TDF) started only a few decades ago and current understanding on its natural regeneration and dynamics is limited. Only recently some successional pathways have been elucidated, and therefore the background for ecological restoration is actively developing. Autoecological knowledge is restricted to a few species and the high species turnover, or beta diversity, of Mexican TDF imposes additional challenges because there are few widespread species and research on the propagation of a high number of species is needed. Currently most research is focused on propagating and growing a number of native plant species and identifying the main ecological filters that sort out those species that are able to thrive in disturbed sites. Seasonality of rainfall and herbivores commonly restrain plant establishment and, as a result, low mean survival (≤ 50%) during the first year after transplanting is quite usual, and initial growth is constrained even in fast growing species. Site conditions, especially soil degradation and lack of nearby patches of primary vegetation are also prevailing ecological filters. In the future restoration plans will most probably be implemented in over exploited, degraded lands, and therefore severe erosion, soil compaction, nutrient loss, and competition from grasses and herbs will be common problems that will need to be addressed. These biophysical conditions, along with problems arising from deterioration of the social network, are the major challenges that large scale restoration of Mexican TDF will have to face.

**Measuring ecosystem services in restored sites: Why? What for? How?**

Bonfil, Consuelo; Raul García Barrios  
Universidad Nacional Autónoma de México

Other than temperate and tropical rainforests, Mexican ecosystems are insufficiently studied and their restoration has to start from a very simple level. Most projects are focused on propagating and establishing a number of native plant species and identifying the main ecological filters that sort out the species able to thrive in disturbed sites. The evaluation of the recovery of ecological interactions and ecosystem-level processes—which is at the core of ecosystem services other than provision of water and CO2 capture—is just starting, and this kind of investigation has some requirements, mainly the long periods of time and large economic funding that are needed to accomplish them. Where does the need to evaluate ecosystem services in restored sites come from? Lately, the main drive has been to measure their economic value for human societies, and thus get the funds needed to sustain them. In a broad sense, it is a way of considering nature functioning from a market perspective, and markets have their own way of communicating value and risks. However, there are three different perspectives from which the value of restoration can be drawn and resources acquired: the private, public and social sectors. All of them can make significant investments of different forms of capital, but each has its own scientific and ethical limitations and drawbacks, which should be carefully addressed when developing restoration projects. These aspects will be discussed, along with the need to develop regulations for the funding of projects aimed at recovering ecosystem services.

**Research experiences toward oak forest restoration in Central Mexico**

Bonfil, Consuelo; Ana Mendoza  
Universidad Nacional Autónoma de México

Although Mexico is the country having the highest diversity of oak species in America, only a few of them have been studied to understand their regeneration dynamics and their requirements for a successful establishment. Here, we review studies regarding seed germination, seedling growth and initial establishment of oak species that have been used in restoration in central Mexico. The most widely studied species is Quercus rugosa, whose germination in natural and experimental conditions has been addressed. There are also reports of plant survival and growth of this species in relation to seed size, seed hydrompriming, inoculation with mycorrhiza, plant age, microsite and nurse plants, as well as comparisons with a few other oak species. Studies on natural regeneration and restoration of oak species are scarce in comparison with reports of germination, which comprise less than ten species (Q. candicans, Q. castanea, Q. crassifolia, Q. crassipes, Q. laurina, Q. glaucoides and Q. macdougallii, among others). The autoecology of many more oak species needs to be studied in order to restore temperate forests of central Mexico; and longer-term studies need to be undertaken. Species that establish in semi-dry regions, as well as in the transition between temperate and tropical dry forests, should receive more attention because of their particular regeneration challenges.
The twenty-first century transition from tropical deforestation to reforestation

Boucher, Douglas
Union of Concerned Scientists, USA

After millennia of cutting down the earth’s forests, mostly for expanding agriculture, humanity is on the verge of a historic change. The “forest transition”, through which societies shift from deforestation to reforestation over several decades, has already taken place in nearly all developed countries and an increasing number of developing ones. Recent evidence indicates that it is beginning to happen in the countries with the largest amounts of tropical forest, such as Brazil and Indonesia. This transition has been encouraged by REDD+ programs and by civil society pressure, and is the largest contribution so far to reducing global warming pollution. The REDD+ provisions in the Cancun Agreements (December 2010) provide a solid framework for global action, but several critical technical and social issues remain to be resolved in ongoing climate negotiations. As deforestation diminishes in tropical countries worldwide, it becomes increasingly important to consider the challenges and opportunities of tropical forest restoration in the twenty-first century. These include cost-effectiveness, effects on biodiversity and the role and rights of indigenous peoples. Although in the next few decades the importance of forest restoration will be less than that of reducing deforestation, reforestation could become a major contributor to the fight against global warming in the second half of the 21st century.

Managing for ecological restoration takes novel approaches - Stories from the field

Bowers, Keith
Biohabitats, Inc., USA

Like it or not, novel ecosystems are here to stay. So how do we design, implement and manage ecological restoration initiatives that embrace the concept of novel ecosystems while at the same time restore ecological functionality and native biodiversity. Using novel approaches, that's how. I will highlight several ecological restoration initiatives, spanning a variety of spatial and temporal scales that have used novel approaches - some by accident, others purposively, to restore ecosystems.

Cultural ecosystem services and socio-economic aspects of a 20-year-old tropical forest restoration project in southeastern Brazil: Links among culture and restoration

Brancalion, Pedro; Ines Villarroel, Cardozo Allan, Camatta Ricardo, Ribeiro Rodrigues, James Aronson
Universidade de São Paulo, Brazil

Despite the large scope in the emerging field of restoration ecology, there are very few studies to date that explicitly explore the complex links between culture and restoration. Here we assess the cultural aspects of ecosystem services and socio-economic benefits in a 20-year old tropical forest restoration project underway in southeastern Brazil. This high-diversity reforestation encompasses a 50 ha site around a dam, which supplies drinking water to the 18,000 inhabitants of the municipality of Iracemápolis. We conducted primary data collection by an interview including various sectors of the local community; and secondary data collection through interaction with public and private institutions in the city. In addition to the economic benefits for seed collectors and improvement of drinking water generation, cultural ecosystem services rendered include aesthetic values (through its scenic beauty, compared to the sugarcane fields of the region), educational values (using the forest for activities at several educational levels), knowledge generation (by the significant amount of scientific research carried out in the forest), recreation (fishing, hiking, and birdwatching), inspiration, ecotourism, and also for religious rites. The results obtained by monitoring this project were also important to help formulate specific legal instruments and public policies supporting high-diversity tropical forest restoration in Brazil. In this context, forest restoration provides several cultural ecosystem services to society, so that the investigation and communication of these benefits may help convince stakeholders of the importance of ecological restoration, advance consensus-building, and improve societal investments in this emerging field.

Income generation through forest restoration: Converting marginal agricultural lands into sustainable forest management lands

Brancalion, Pedro; Ricardo Ribeiro Rodrigues
Universidade de São Paulo, Brazil
After hundreds of years of resource exploitation, and landscape transformation, the Brazilian Atlantic Forest now demands urgent efforts of ecological restoration and reintegration in order to reconnect the isolated forest patches and reconcile sustainable land use and ecosystem management with agricultural production. Given the advanced state of alteration and degradation, restoration efforts are necessary to support biodiversity persistence and the re-establishment of steady flows of ecosystem goods and services to society. However, since most restoration efforts must be carried out on private lands, landowners must be convinced that it is in their interest to restore their lands, rather than simply obliging them to do it by legal instruments. In this context, one promising strategy is the development of restoration models that allow exploitation of timber and non-timber forest products from native species in restored areas on private lands. This approach is particularly interesting because historical degradation of the Atlantic Forest has also limited the supply of valuable forest products, which bring high prices in national and international markets. Hence, the development of integrated models of tropical forest restoration that incorporate economic exploitation of resources for landowners along with societal conservation objectives, should help convince landowners to restore their lands and also help to upscale restoration efforts at the biome scale. In this presentation, we will show some case studies of economic models of Atlantic Forest restoration that allow farmers to double the income currently obtained by extensive cattle ranching, the predominant occupation of marginal agricultural lands.

**Building Seneca local assessment in upstate New York under the indigenous peoples’ biocultural assessment initiative (IPCCA)**

**Bray, Kaylena**

Seneca Interantional, USA

The Seneca tribes of Western New York are increasingly affected by climate change. The 12,000 or more years of interdependency between Seneca culture and their environment -- which created an inextricable link between people and their lands and waters, and had ecological impacts on the health of nature -- are relevant to modern natural resources management and climate change adaptation. Today climate change is affecting all aspects of the environment important to the sustainability of Seneca culture. Some of these impacts can be addressed if Seneca biocultural and social adaptations can be assessed, and the Seneca wealth of knowledge and experiences about protecting, enhancing, and restoring natural ecosystems used to develop future responses aimed to help nature to resist and adapt to climate change. Managing Seneca traditional agricultural landscapes and corn crop varieties as well as maintaining diverse landscapes can help ensure healthy food supplies even in uncertain conditions. This presentation will focus on the development of a Local Assessment in Seneca territory located in western New York that is being advanced by Seneca International and developed following the Indigenous Peoples Biocultural Assessments Initiative (IPCCA) methodologies, strategies and goals. The presentation will inform participants of the workshop of the various means Seneca International is using for the development of the assessment, then describe the process; its benefits and shortcomings; the role of the tribal authorities; community engagement; the development of assessment action plan; and recommendations for building a Local Assessment on Climate Change under the IPCCA initiative.

**Transdisciplinarity and porosity**

**Brookner, Jackie**

Parsons School of Design, USA

Long term success of ecological restoration, at all scales from the local to the global, necessitates transformation of the dominant ways humans understand, behave, value, and relate to natural processes and ecosystems. Artists and scientists can do more together to affect positive transformation than either can do separately. It is not a matter of the scientists providing the hard-core research and artists the soft outreach, rather the dynamics engendered in the space between disciplines is full of information necessary to solve complex problems at the systemic level. Transdisciplinarity implicitly raises the issue of boundaries, which themselves are a rich territory to explore. What happens when one meets the edges of their expertise? These initially uncomfortable edges become fecund places of emergent creativity, similar to enhanced diversity in the boundary zones of ecosystems. Unforeclosed by disciplinary constraints, these places of open curiosity generate non-paradigmatic responses to problems. How does problematizing the impermeable boundary play itself out in actual ecological restoration projects initiated through art practice? Ecological artist Jackie Brookner will explore this through examples of her water remediation/public art projects where she collaborates with ecologists, hydrologists, landscape architects, communities and policy makers. While permeability is necessary to the ecological functioning of these works, it is also the subject of their imagery. This work provokes inquiry about the boundary making practices through which we define ourselves as individuals and as a species. Transforming assumptions about these boundaries and their exclusions is foundational to sustained ecological restoration.
El cine como medio para promover las acciones de restauración ecológica a partir del conocimiento ecológico tradicional

Bross Soriano, Simón; Samuel I. Levy-Tacher, Francisco Román-Dañóbeytuia
Bross al cuadrado S.A de C.V, Mexico

Los medios audiovisuales ofrecen la oportunidad de aproximar al público a la comprensión de la problemática ambiental y en particular de las acciones de restauración ecológica necesarias para la recuperación de áreas agropecuarias degradadas y la conservación de las selvas tropicales. El uso del video como instrumento de divulgación de conocimientos tiene múltiples ventajas, permite informar a las instituciones y funcionarios gubernamentales sobre un tema en particular de manera sucinta y efectiva, facilita la capacitación de los agricultores en sus comunidades, es un excelente instrumento para recuperar y difundir el conocimiento tradicional, resulta muy útil en la impartición de seminarios y talleres, y su reproducción y copiado no implica costos altos. Sin embargo, existen muy pocos materiales audiovisuales diseñados para su utilización en las regiones selváticas, que retomen la historia de las culturas que las habitan, que muestren la riqueza de sus recursos naturales y que sumen estos dos conceptos dentro de un enfoque integral de restauración ecológica. Aprovechando las posibilidades del medio audiovisual, es posible describir las antiguas tecnologías tradicionales enriquecidas con las recientes innovaciones tecnológicas para formar una unidad que vincule ambos conocimientos. De esta manera, la realización de documentales retoma los conocimientos locales y se adecua a las necesidades y objetivos contemporáneos del manejo y conservación de la biodiversidad.

Restoring the health and resiliency of northern Gulf of Mexico ecosystems for people and nature

Brown, Cindy
The Nature Conservancy, USA

The northern Gulf of Mexico is one of the few places in America where the health of the environment is so obviously linked to the health of the economy and community. Vital commerce and industry and rich coastal and marine ecosystems have coexisted for generations in the Gulf. The economy of the United States as a whole is tightly linked to the energy, shipping and other industries that operate in the Gulf region. However, decades of ecosystem degradation, punctuated by the Deepwater Horizon accident, affect the Gulf’s ability to support these needs and the needs of wildlife, directly impacting the lives and livelihoods of 24 million Americans from Florida to Texas. Ironically, the Deepwater Horizon accident created a series of opportunities which could now set the northern Gulf of Mexico on the road to ecological and economic recovery. Currently, there is an opportunity to establish a restoration fund for the Gulf thru Clean Water Act fines and other legal avenues that could generate billions of dollars to restore ecosystem health. Also, the NGO community is creating a draft Strategy for Restoration to assist the Gulf Coast Ecosystem Restoration Task Force in determining the goals and outcomes for system scale restoration. Importantly, the conservation community, including The Nature Conservancy, has been doing restoration work in the gulf for decades, partnering with local communities and demonstrating the tools and knowledge needed to build restoration projects that result in the greatest ecological and economic benefits.

Leveraging watershed restoration as a proactive approach to global climate change adaptation and ecosystem resilience

Browning, Carolyn; Matthew A. Wilson
ICF International, USA

Adaptation and resilience to climate change is requiring new approaches and thoughtful, preventive actions to reduce the vulnerability of watersheds and the ecosystem services they provide. This paper discusses challenges and opportunities associated with linking observed and projected climate changes to watershed restoration at local and regional levels. The need for change in conventional watershed management and planning approaches based on historic weather regimes is supported by observed climate variability and extreme weather events that adversely impact watershed systems. A conceptual framework is proposed to facilitate a shift to proactive climate change adaptation for watershed ecosystems. Building on the field of restoration science, the framework translates fundamental principles from ecological theory into practical terms that can be used by watershed managers to improve resilience and sustain delivery of ecosystem services into the future. Two case studies are used to demonstrate how the proposed framework can guide a more holistic watershed restoration approach. A case study from the Upper Arkansas River Basin in the United States is presented to showcase how watershed restoration planning is being leveraged to increase ecosystem resilience and adaptive capacity in the face of extreme weather
events associated with climate change. Another case study from Guy Fawkes River National Park in Australia is used to illustrate how watershed based climate adaptation strategies can mitigate impacts from invasive species. Linking climate change adaptation and the science of ecological restoration with watershed management practices will help to guide restoration efforts in river basins at various scales throughout the world.

Role of the seed bank and seed rain in the regeneration of a transition forest near Andohahela National Park, Madagascar

Buisson, Elise; Fanambinantsoa Noromiarlyanto, Harijaona Ramanoelina, Harison Rabarison, Fidisoa Ratovoson, Mélissa De Wilde, Porter P. Lowry II
Université d’Avignon, France

This study investigates the resilience of a transition forest on now-abandoned field. The study sites are located midway along a precipitation/altitudinal gradient across a corridor between two large parcels of Andohahela National Park: an upland parcel of humid forest and a lowland one of dry spiny forest. Restoration of gaps in this corridor may be essential to retain connectivity as the impacts of climate change are likely to be severe in this region. Vegetation surveys carried out in 2009 on 23 abandoned fields showed that they are not colonized by forest species and that succession often leads to a dense thorny thicket of Mimosa delicatula. Two tests were conducted in 2010: 1) to assess more precisely regeneration potential in the fields, the seed bank and seed rain were studied on three fields and adjacent forest patches; 2) to examine possible restoration involving nuclei of forest species on the fields, samples of the seed rain and soil were transferred from the same forest patches to the fields. In the forest patches, the seed bank and seed rain are dominated by woody species indicating a potential for regeneration, although seed dispersal must be low as no forest species were found in the seed banks on the fields, which are dominated by Poaceae as well as herbaceous taxa. The seed rain transfer yielded little germination, which did not survive an atypical dry period during the rainy season. The soil transfer did not lead to any germination. Other regeneration options are discussed.

Biophysical effects of herbicides and adjuvants used in bushland management activities, on plant species native and invasive to Western Australia

Bundock, David Mark; Kingsley Dixon, Deanna Rokich, Christoph Hinz
University of Western Australia

Investigations were undertaken to collect information related to the effects of commonly used herbicides and adjuvants on seed germination, emergence, radicle growth, shoot growth, persistence, temperature sensitivity and health of six species native to southwest Australia, together with four co-occurring introduced species. Experiments investigate the effects of chemicals on plants and involved several variables, including soil type, burial depth, in-situ, ex-situ, chemical concentration and temperature. Results of the experiments show herbicidal effects on off-target species as well as target species in all phases of growth. The degree of effect is related to soil type, burial depth and temperature as well as concentration of the test chemicals. Some herbicides consistently display off target effects, which are particularly damaging to the major species of jarrah woodland, such as Acacia pulchella, Eucalyptus marginata and Banksia grandis. Adjuvants often exhibit a more profound effect on plants than the herbicides and in many experiments are by far the most damaging chemicals. In other instances the adjuvants promote earlier germination and emergence of weed - seeds, even under adverse temperatures. Results support independent research, but contradict the claimed characteristics of the chemicals by their manufacturers, which include; grass selectivity, non-reactivity in soils, post-emergent activity and inert chemicals (adjuvants). Implications of the use of these chemicals for bushland restoration will be discussed.

Is restoration success synonymous for vegetation and fauna? Investigating the congruence between vegetation and bat succession in restored bauxite mine-pits

Burgar, Joanna; Michael Craig, Vicki Stokes
Murdoch University, Australia

Restoration is an important tool in the battle to preserve biodiversity; however, to be effective restoration needs to support all components of the ecosystem, including fauna. One, often unstated and rarely tested, assumption is that fauna will naturally recolonise restored areas once vegetation establishes, yet this is unlikely to be the case in many ecosystems. One of the world’s largest bauxite mines is situated in the biodiversity hotspot of south-western Australia. Within this hotspot, 600 ha of jarrah (Eucalyptus marginata) forest is annually cleared, mined and restored. Although current restoration practices aim to restore a self-sustaining jarrah forest ecosystem, little research
has focused on the ability of fauna to recolonise restored mine-pits or whether patterns of faunal recolonisation mirror those of vegetation succession. We investigated the impact of restoration on fauna in a number of different aged stands of varying eucalypt and legume densities, using bats as the focal taxa. Bat activity was significantly higher in unmined forests than restored mine-pits regardless of restored forest age, eucalypt or legume density. Bat activity was positively correlated to invertebrate prey availability, which was also significantly higher in unmined forests. Restored mine-pits currently comprise dense forests that limit bat foraging activity and prey accessibility. Restoration practices need to result in less densely

**Safeguarding Biodiversity**

**Burgar**, Joanna; **Michael Craig**, Vicki Stokes

**Murdoch University**, Australia

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**REDLAN: Latin American network of ecological restoration**

**Bustamante Sánchez**, Marcela; **Cristian Echeverría**, Luiz Duarte, Adriana Rovere, Fabiola López, Milagros Jiménez, César Jiménez, Franklin Chambas, Vicente Martínez, Edgar García, Edgar Gareca

**Universidad de Concepción**, Chile

REDLAN was created in 2005 in Valdivia, Chile, as a result of the necessity for affronting the theoretical and practical challenges about ecological restoration in Latin America. REDLAN’s main objectives are: i) to promote research on ecological restoration in Latin America, ii) to exchange experiences and knowledge among researchers and professionals working on restoration projects in the region, iii) to develop collaborative actions on ecological restoration. At present, REDLAN is represented in Argentina, Bolivia, Brazil, Chile, Costa Rica, Ecuador, Guatemala, México, Paraguay and Perú. A wide variety of projects with diverse objectives have been conducted by REDLAN members, such as restoration of protected areas affected by fire or by plant invasion, threatened plant and animal species, degraded habitats in tropical, subtropical and temperate zones, and studies on plant propagation and genetic variability. Challenges faced by local researchers to conduct ecological restoration actions are similar in the region: lack of a national policy on restoration of degraded ecosystems, scarceness of local financial resources, impossibility to conduct long-term studies, and financial dependency on abroad institutions. We observe an increasing interest of local researchers, governmental representatives and land managers in receiving training about restoration techniques and methods. Also, there is a need of strengthening REDLAN in those countries where ecological restoration is still incipient.

**Need for integration of ecological, economic and social constraints in restoration planning in Chile**

**Bustamante Sánchez**, Marcela; **Cristian Echeverría**, Cecilia Smith-Ramírez, Milena Holmgren, Ignacio Schiappacasse, Laura Nahuel, Juan J. Armesto, Julián Reyes

**University of Concepción**, Chile

In Chile, various legal instruments consider restoration as a desirable activity and even mandatory (e.g. mitigation or compensation measures). We examined the degree of integration between the science and practice of ecological restoration (passive/active approaches), on the one hand, and economic and social constaints, on the other. The success of restoration activities relies on tools grounded in social and ecological science; however this theoretic-practice relationship has recently begun. In the Mediterranean and Temperate regions of the country, assessments of
the current conditions of degraded lands have been done and possible constraints to regeneration have been identified. In very degraded ecological contexts (areas in central Chile), an active intervention is required to overcome these constraints, but in less degraded areas, passive restoration remains as a truly possible option. Reports with recommendations to improve restoration practices are almost nonexistent. Most of the active restoration initiatives have not used adequate monitoring schemes and do not publish their failures or successes. Most of the publications come from academics or people from research institutes, and use a technical language that is not understood or read by practitioners. Finally, a gap exists between research on ecological and socioeconomic issues. Few projects have considered interviews with local people, finding that there is a low interest of landowners to restore with native species as most of the benefits from restoration do not necessarily accrue to them. A prioritization of activities is required in terms of what is possible ecologically, most efficient financially, and acceptable socially.

**Threatened coral recovery: Acropora coral restoration in Florida and the U.S. Virgin Islands**

**Byrne, James; Caitlin Lustin, Meaghan Johnson**

The Nature Conservancy, USA

Due to significant declines in Acropora coral coverage throughout the Caribbean, the need for active restoration of both *Acropora cervicornis* and *Acropora palmata* has become apparent. In 2009, under the American Recovery and Reinvestment Act, NOAA recognized this need and funded a large-scale coral restoration project. The aim of this project is to enhance degraded coral reefs throughout Florida and the U.S. Virgin Islands. The long-term goal is to increase acroporid larval production and genetic diversity by increasing the likelihood of successful cross-fertilization between genetically distinct colonies located on outplanted restoration sites at an ecologically significant scale. This project represents an active form of coral reef management. The end goal is to strategically outplant at least 5,000 coral colonies to reefs that once supported large thickets of acroporid corals throughout South Florida, the Florida Keys and the U.S. Virgin Islands. Through careful site selection, this outplanting is designed to increase the chances of successful sexual reproduction, thereby encouraging the reseeding of natural reefs. Additionally, the nurseries serve as a repository of coral genotypes.

**Does rewetting restore net DOC production at degraded fen areas?**

**Cabezas, Álvaro; J. Gelbrecht, E. Zwirnmann, D. Zak**

IGB, Müggelseedamm, Germany

Any change in DOC fluxes in peatlands will result in a regional redistribution of terrestrial C. Artificial drainage of peatlands increases DOC production by stimulating the aerobic decomposition of organic matter, what impairs the role of peatlands as sinks of atmospheric carbon. Moreover, the functioning of adjacent aquatic ecosystems might be greatly impaired. Increasing water tables has been proposed in order to decrease C mineralization rates, and so net DOC production. However, previous research has shown that rewetting can increase net DOC production. We focused on degraded fen areas, i.e. groundwater-fed peatlands. We hypothesized that three different factors will promote different restoration trajectories in terms of net DOC production. Firstly, peat decomposition alters the size of the mobile DOC fractions and alters the hydraulic conductivity of the peat. Secondly, anthropogenic drainage at local and regional scales makes it often impossible to recover pre-disturbance hydrological dynamics. Finally, it is expected that restoration of severely degraded fens results in the development of new ecosystems with different vegetation communities than those observed at natural fens, altering primary production and litter quality, and so net DOC production. In this study, porewater DOC and its composition were analyzed for an array of natural, drained and rewetted fens on NE Germany (n=28) in order to characterize their net DOC production, as well as their hydrology and vegetation characteristics were described. We propose different restoration trajectories depending on peat composition, hydrology and vegetation, and provide useful insights for practitioners and future research.

**Bridging the science/practice gap: Results and analysis of a 2009 SERI delegate survey**

**Cabin, Robert; A. Clewell, K. Dixon, C. Murcia, V. Temperton**

Brevard College, USA

Developing and strengthening a more mutualistic relationship between the science and practice of restoration has been an elusive goal of restoration scientists and practitioners. We surveyed the delegates to the 2009 SERI World Conference to learn more about their perceptions of and ideas for improving restoration science, practice, and scientist/practitioner relationships. The respondents’ assessments of restoration practice were less optimistic than their assessments of restoration science. Only 26% believed that scientist/practitioner relationships were “generally mutually beneficial and supportive of each other,” and the “science–practice gap” was the second and third most
frequently cited category of factors limiting the science and practice of restoration, respectively. Most of their suggestions for bridging this gap focused on developing more political support for restoration and creating alternative research paradigms to both facilitate on-the-ground projects and promote more mutualistic exchanges between scientists and practitioners. My experiences as both an academic researcher and applied restoration practitioner have also led me to conclude that the kind of "real science" demanded by academia and funding agencies may not necessarily be an effective way to support applied restoration programs. I thus argue that a less formal, more trial-and-error methodology may often be a more effective and efficient way to facilitate and perform on-the-ground restoration in the messy real world. I support these arguments for a more "Intelligent Tinkering" approach (as argued and demonstrated by Aldo Leopold) with case studies and interviews of a broad spectrum of the restoration community.

**Silvopastoral systems: Making cattle ranching part of the solution to tropical land degradation**

**Calle, Zoraida; E. Murgueitio, A. Calle, F. Uribe**

Centro para la Investigación en Sistemas Sostenibles de Producción Agropecuaria, Colombia

Extensive cattle production occupies more than 27% of the rural landscapes in Latin America, and continues to expand. This activity, deeply rooted in the culture and economy of the region, is undergoing a significant transformation aimed at becoming more efficient and environmentally friendly. Silvopastoral systems that incorporate native trees and shrubs are instrumental for the productive rehabilitation of degraded lands and for biodiversity conservation in agricultural landscapes. Research progress and the adoption of intensive silvopastoral systems in Colombia are discussed. Intensive silvopastoral systems (ISS) are a sustainable form of agroforestry for livestock production that combines fodder shrubs planted at high densities (more than 10,000 plants ha⁻¹) with trees, palms and improved pastures. High stocking and the natural production of milk and meat in these systems are achieved through rotational grazing with electric fencing and a permanent supply of water for the cattle. While milk and meat production and cattle reproduction are enhanced, production costs decline as external inputs are replaced by natural processes related to fertility and biological control. This presentation discusses the role of ISS with native trees for climate change adaptation and mitigation, the barriers for their adoption, and how these have been successfully addressed by using payment for environmental services, special credits and technical assistance. Finally, the talk highlights the need for enhancing landscape connectivity by integrating silvopastoral systems to conservation corridors with native species to promote biodiversity conservation and other environmental services demanded by society.

**Restoration of areas affected by severe erosion in the Colombian Andes: Some lessons learned**

**Calle, Zoraida; J. A. Sinisterra, M. Carvajal, G. López, E. Murgueitio**

Centro para la Investigación en Sistemas Sostenibles de Producción Agropecuaria, Colombia

The combined use of vegetation and inert mechanical structures can efficiently contribute to stabilize the slopes affected by failures and mass movement in the densely populated Colombian Andes. Landslides and upland-migrating gullies are two common manifestations of land degradation in this region, where intrinsic factors such as geologic instability, steep relief and heavy rainfall act together with anthropogenic disturbances (i.e. overgrazing, road construction and poor soil conservation practices), to cause significant human and economic loss and ecosystem degradation. The approach to restoring severely eroded slopes combines the use of soil stabilization structures made with Guadua angustifolia (bamboo) stalks with high-density planting of native species that exhibit quick growth and sprouting. The interlocking roots of trees, shrubs and herbs provide deep and lateral anchorage, while complex vegetation restores slope stability by enhancing soil resistance to breaking. In turn, soil stabilization and vegetation growth promote the recovery of ecological processes. Lessons learned from the application of this restoration strategy to 60 eroded sites include: 1. It is feasible to replace some biomechanical structures with plants capable of performing the same functions. 2. Although the complete recovery of unstable slopes can be achieved through this approach, pressing human needs pose a significant threat to the restoration process. 3. Prevailing aesthetic standards can compromise the stability of restored slopes. 4. Colombia urgently needs a legal framework to help protect restored areas. 5. Such restoration interventions should allow a moderate use of the land with direct economic benefits.

**Evaluating ecological restoration in mine sites: Participatory methodologies to involve practitioners**

**Carabassa Closa, Vicenc; E. Serra, O. Ortiz, J. M. Alcañiz**

Universitat Autònoma de Barcelona, Spain

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The evaluation of ecological restorations carried out in open cast mining sites is a fundamental step in the restoration process. The involvement of technicians like quarry engineers, restoration managers and supervisors of public administration in this process can substantially improve the outputs of the restoration activities. A self-evaluation protocol for quality control of restoration results has been designed in order to involve technicians and establish a common set of criteria. Participatory methodologies have been implemented in the design and testing process using personal interviews as a first step. The main objective of these interviews was to compile indicators of the main parameters to consider in the restoration assessment. In the next phase, a group of practitioners was integrated in an expert panel that weighed the proposed parameters of restoration quality and proposed optimum and limit values for each one. As the final step, a field trial of the protocol was performed with practitioners allowing the detection of excessively complex indicators or measuring methods. All the resulting parameters from the assessment protocol can be now easily measured by a non-scientific user, with the exception of those related to soil characteristics. The parameters used in the evaluation are grouped in: (i) general parameters, which are related to the whole restored area (e.g. ecological connectivity, landscape integration), and (ii) site-specific parameters, related to homogeneous sectors within the restored area, such as slopes or terraces (e.g. geotechnical processes, efficiency of the drainage web, vegetation characteristics).

Factors that influence successional trajectory in the restoration of pastures in Southern Brazil

Cardoso, Fernanda C. Gil; Marcia C. M. Marques
Universidade Federal do Paraná, Brazil

Over the last century, the Brazilian Atlantic rainforest has suffered strong impact due to deforestation for agriculture and grazing activity. Natural forest areas that had been replaced by pastures are now being restored either naturally, or by means of native species plantations. To evaluate the forest recovery using different methods is a key factor to conserve biodiversity. In this study, we analyzed the structure of plant communities under restoration process in the Atlantic Forest in Southern Brazil, aiming to verify whether factors such as type of restoration, soil type, age, species of pasture used and relief can influence forest restoration in abandoned grazing areas. We selected 60 circular plots along the restoration areas and they belonged to two types of restoration (natural regeneration and plantation), four soil types (Cambisol, Gleysol, Argisol and Neosol), four ages (2, 4, 6 and 8 years), four pasture types (Brachiaria humidicola, B. decumbens, Poaceae and Mixed) and two types of relief (Lowlands and Hillsides). Our results demonstrated that the type of pasture preceding restoration is the strongest single factor influencing species diversity and abundance of both adult and seedling/shrub communities; being the exotic grass B. decumbens the one that most negatively influences restoration. The strongest multiple regression model explaining species richness and abundance was the one containing restoration and pasture types. Nevertheless, it was type of restoration the factor that better explained adult basal area. These results suggest that the combination of factors is important to the successional trajectory of plant communities and should be taken into consideration when planning restoration actions.

Ecosystem service valuation methods: Research and policy dimensions

Casey, Frank
US Geological Survey

This presentation will focus on the research and policy dimensions of applying ecosystem service valuation methods on private agricultural lands in the United States, and what this implies for the restoration and the sustainable management of natural resources. With respect to applied ecosystems research on the services that ecosystems generate, valuation takes place after defining ecosystem structures and functions, and the outputs of those functions that are useful to humans. Included in the presentation will be a brief overview of various economic valuation methods and tools, selected implementation experiences with these methods and tools, constraints and strengths of implementation, and which approaches may be most useful in a developing country context. The second part of the discussion topic will be illustrated through specific schema or visual frameworks that will show the linkages among ecosystem processes, ecosystem service valuation, adaptive management, and policies for ecosystem restoration. Such a framework is now being developed by the Science and Decisions Center at the United States Geological Survey. Public policies and programs that influence the viability of using ecosystem service valuation (i.e. outcome-based) techniques will be explained and examined. Important topics/issues to consider will include definition of the scope and scale of the ecosystem service, bundling of services, outcome measurement and metrics, and linkages to payment mechanisms. The implications of these issues for developing countries will be explored.
Fire regimes, climate change and adaptive management in the Sierra de Manantlán Biosphere Reserve in Jalisco and Colima, México

Cassell, Brooke; E. A. Celestino, E. J. Peláez, D. P. Salicrup
University of Washington, USA

Fire, both anthropogenic and lightning-ignited, is one of the most influential factors in vegetation community and succession in the Sierra de Manantlán Biosphere Reserve in Jalisco and Colima, México. A mosaic of low, mixed and high severity regimes characterizes the topographically complex landscape with ecosystems ranging from mesophyllous mountain forest to higher elevation pine and oak forest. Some species, such as the culturally important Zea diploperennis maize and the rufus hummingbird rely on open stands maintained by frequent low-severity fires. Others, such as the threatened jaguar, require dense cloud forest, necessitating a careful approach to maintenance and restoration of the landscape. Increases in fuel loadings and change in vegetational structure since the reserve’s establishment in 1986 may have changed the fire regime, resulting in feedback loops. We are constructing a tree-ring master chronology and reconstructing fire history from fire scarred trees at pine-dominated sites throughout the reserve; analyzing changes to the fire regime following establishment of the reserve and the impacts to successional patterns, habitat and potential impacts on future fire occurrence and severity; and examining climatic patterns and their relationship to fire occurrence and severity. This research will create a baseline of knowledge about the fire regime and historical range of variability, facilitating scientifically informed land and fire management plans. This will be only the second dendrochronologically obtained fire history south of the Tropic of Cancer in the Western Hemisphere and will contribute to Mexico’s goal of defining nationwide fire regimes.

Programa de restauración y compensación ambiental de la CONABIO

Castañeda Sánchez, Mario; M. del Carmen Vázquez Rojas, Yvonne Simms del Castillo, Guillermima Echeverria Lozano
Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, México

El Programa de Restauración y Compensación Ambiental (PRCA) de la CONABIO, se instauró en septiembre de 2003, representando un cambio positivo en la historia de la restauración ecológica y conservación en México, ya que abrió la posibilidad de canalizar recursos de manera rápida y directa a acciones concretas para recuperar y conservar ecosistemas y recursos naturales de nuestro país. Los proyectos que se han financiado a través del PRCA, obedecen a líneas temáticas, prioridades y bases establecidas por un Consejo Asesor, tomando en cuenta las necesidades del país en materia de restauración y conservación y acordadas por los sectores gubernamentales, social y académico. Este Consejo Asesor vigila que se obtenga el mayor beneficio con el uso de los recursos, estableciendo líneas temáticas, prioridades y bases para su ejercicio. A la fecha, a través de este programa se han publicado 10 convocatorias con las que se han financiado alrededor de 150 proyectos, por más de 150 millones de pesos, de los cuales han concluido cerca de 118 trabajos relacionados con los temas de restauración ecológica y conservación ambiental. Algunas de las acciones llevadas a cabo con estos fondos son reforestación, pago por servidumbre ecológica, monitoreo de arrecifes y manglares, rehabilitación de suelos, manejo silvopastoril, protección de arrecifes y combate de incendios en ANP, entre otros.

Uso de multi-criterios para la determinación de especies con potencial de bioenergía en zonas áridas

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El uso de nuevas especies con fines bioenergéticos que no compitan con especies ya utilizadas en la alimentación ó la industria es prioritario para el desarrollo de fuentes alternativas de energía. Dado el largo tiempo que requiere un proceso de domesticación y selección de las especies con mayor potencial, nosotros desarrollamos el uso de multi-criterios para seleccionar aquéllas especies que puedan representar el mayor potencial de utilización “de novo”, bajo condiciones de poca o mínima información disponible. Se seleccionaron diversos atributos de las especies enmarcados en criterios geográficos, ecológicos, ecofisiológicos, químicos y socioeconómicos, para determinar el mayor potencial de las especies analizadas. Presentamos una primera selección de especies de zonas áridas con potencial de ser utilizadas como fuente de bioenergía, que pueden ser utilizadas directamente ó establecidas con fines de restauración.
Restauración de campos agrícolas abandonados en la Costa de Hermosillo, Sonora, México
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Dado el agotamiento y encarecimiento del suministro de recursos suplementarios como agua, fertilizantes y electricidad, la restauración de campos abandonados es una necesidad cada vez mayor, en particular en áreas agrícolas marginales, áridas y semiáridas. Bajo condiciones marginales, el re-establecimiento de actividades productivas tradicionales presenta retos biológicos, ecológicos y socioeconómicos muy grandes, por lo que es necesario considerarlos en la planeación de su restauración. En este trabajo se sintetizan los resultados de diferentes aproximaciones al restablecimiento de campos de cultivo abandonados, utilizando diversas formas de transplante de especies con potencial de utilización. Resultados utilizando conceptos de facilitación vía la creación de relaciones de nodrizismo e islas de fertilidad fue puesto a prueba en condiciones de mínima suplementación de agua y recursos. Se discute el papel de los factores bióticos y abióticos determinantes en el éxito de la restauración en zonas áridas.

Conectividad productiva: Estrategia para restaurar paisajes ganaderos en la Amazonía Colombiana
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Fundación Esawá, Colombia

El área de estudio se localiza en el piedemonte andino-amazónico colombiano, departamento del Caquetá, cuyo poblamiento data de finales del siglo XIX y comienzos del XX motivado por la extracción del látex del Cauchó (Hevea brasiliensis) y posteriormente por la extracción de madera, lo que origina la transformación paulatina del bosque húmedo tropical a bosque fragmentado por pastizales y a extensas áreas de pastizales con pequeños remanentes de bosque. El trabajo se realiza en dos zonas con características distintas: La primera en el municipio de Florencia, corregimiento de San Martín, presenta mayor consolidación de la ganadería y por ende mayor intervención antrópica que se visibiliza en el estado de la cobertura vegetal. La segunda en el municipio de Belén de los Andaquíes, microcuencas del río Sarabando, hace parte de la zona amortiguadora del Parque Natural Alto Fraguía Indi Wasi, que a pesar de registrar un poblamiento más antiguo que la primera, cuenta con mayor conservación del bosque. Se evidencia al comparar las dos zonas que la predominancia de pastizales asociado a mayor accesibilidad contribuye a la valorización de los predios a pesar de su deterioro ambiental. Las dos zonas tienen en común que corresponden a predios de pequeña extensión (en promedio 50 ha), donde se tipifica una estructura económica de carácter campesino con baja productividad. Con la conectividad ecológica-productiva se pretende, de una parte, disminuir los efectos ambientales negativos de la ganadería dada su característica extensiva, y de otra generar mejoras en las condiciones productivas de los predios e ingresos de las familias.

Importancia de la caracterización y evaluación de las propiedades edáficas en el proceso de rehabilitación y restauración ecológica en una explotación minera a cielo abierto (cantera de yeso)
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La industria minera es, además de agresiva con la naturaleza, una actividad transitoria y no definitiva, por ello, una vez finalizada la explotación se necesita una restauración ecológica, que según la SER (Society for Ecological Restoration) es el proceso de restablecer un ecosistema que se ha degradado, dañado o destruido. La restauración de la vegetación en las explotaciones mineras a cielo abierto tiene el problema de que el suelo original ha sido eliminado, dejando como medio de crecimiento para las plantas lo que se conoce como “soil – forming materials” (SFM). Una de las limitaciones de los SFM es su escasa estructura edáfica. El objetivo principal de este trabajo es la comprensión de la naturaleza, propiedades y funciones de suelos de yeso como una parte a incorporar al ecosistema para la reconstrucción de un nivel edáfico (tecosuelo) que permita regenerar la vegetación. Para alcanzar este objetivo, es necesario un estudio de los suelos circundantes ya que tienen que ser la referencia principal para los suelos de reposición. El tipo de suelo, la textura del sustrato, los nutrientes del suelo, el pH y la conductividad eléctrica juegan un papel decisivo en este proceso. Este análisis debería ser el inicio de cualquier programa de rehabilitación. Se han estudiado un conjunto de 22 muestras de suelo correspondientes a distintas áreas circundantes que fueron clasificados (según la clasificación de FAO 2006) como tres tipos diferentes: regosol gypsic, leptosol eutrófico y cambisol calcáreo.

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Proposal to restore forests natural protected areas in Tabasco, Mexico

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In Tabasco has lost 90% of its original vegetation of forests by changing land use from forest to agriculture and livestock practices. The objective of this proposal to make a diagnosis of forests and find remnants of primary and secondary vegetation for management and restoration proposals. Development of a land use map of 2010 with the support of GIS. It made 200 trips to the countryside to check on the 17 municipalities establishing sites where primary and secondary vegetation with different plant associations which are located geographically. Selections were 30 sites to establish monitoring sites for soil erosion. The distribution, structure and floristic composition of secondary vegetation varies depend on the degree of alteration of the original vegetation. In slightly altered sites were located trees: Brosimum alicastrum, Ceiba pentandra Dialium guianense and average height with greater than 30 m in relict forests in natural protected areas of Macuspana, Tenosique Teapa, Tacotalpa. On disturbed sites abound Bursera simarouba, Spondias mombin, Cecropia obtusifolia, and Attelea butyracea. Is actively involved with communities and women's organizations and in the Ejido Villa Guadalupe, Huimanguillo where conserved and contribute to the restoration of Forest and through UMA acuahulas Orchid. Proposal management and restoration of floodplain forest canacoite (Bragaysia integerrima) Plan Chontalpa Cardenas. Restoration of forest ecological reserve, Yumka, Centro. Reform and Ecological Reserve, Balancán.

Restauración ecológica con sistemas agroforestales en el manejo de canteras en Yucatán

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En Mérida, Yucatán existen alrededor de 1000 has de canteras que impactan al ambiente tras su abandono. En MAPSA se realizaron pruebas de adaptación de especies en sistemas agroforestales de 1989 a 2002. El pasto estrella (Cynodon niemfuensis) asociado con huaxín (Leucaena leucocephala) produjo 7500 kg MS ha-1 a 6 meses de la siembra. El huaxín tuvo 95 % de sobrevivencia, creció casi 3 m a 9 meses de la siembra y fijó 70 kg N ha-1 año-1 cuando fue utilizado en pastoreo. No obstante, Heteropsylla cubana infestó al huaxín en 1994 por lo que se evaluaron otras especies. El pixoy (Guazuma ulmifolia) tuvo el mejor rendimiento en biomasa y fue aceptado por ovinos. El cedro (Cedrela odorata) y la caoba (Swietenia macrophylla) crecieron casi 15 cm de diámetro a 8 años de plantados. De 2003 a 2008, se evaluó el crecimiento de otras 22 especies, destacaron: ramón (Brosimum alicastrum), cedro, melina (Gmelina arborea) chac bojón (Colubrina arborescens), guano (Sabal sp.) y la variedad K636 de huaxín. En MAPSA se han restaurado 45 has con un total de 35 especies cultivadas y toleradas. Con la restauración de la cantera se han propiciado los servicios ambientales siguientes: captura de carbono, fijación de nitrógeno, control natural de plagas, refugio y alimento para la fauna silvestre. La experiencia de MAPSA ha contribuido a la formación de estudiantes de licenciatura y posgrado en ciencias biológicas y agropecuarias, en especial en sistemas agroforestales para la mitigación del impacto ambiental y la restauración de ecosistemas.

Carbon vs. biodiversity outcomes from differing tree-planting designs: Trade-off or synergy in tropical Australia?

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The emergence of carbon markets has provided a potential source of funding for tropical forest restoration, which is also important as a tool for averting biodiversity losses and species extinctions that are currently likely if landscapes remain heavily-cleared. To what extent are these goals compatible within particular plantation designs? Biosequestration projects tend to adopt plantation designs that were developed for timber production, using fast-growing tree species at low diversity and density. By contrast, many species of forest-dependent fauna and flora have specific habitat requirements such as dense foliage in multiple strata, a closed canopy and need particular resources or cues such as fruits, phytochemicals or dead wood. These are better provided by ecological restoration plantings which establish trees and some other life-forms at high density and diversity. We tested for synergies or trade-offs in these goals by measuring both above-ground carbon and biodiversity (as indicated by species composition of birds, plants and epigaecic beetles) in replicate sites of three types of young plantation: monoculture timber, mixed-species timber and ecological restoration, in a rainforest landscape of north-eastern Australia. Ecological restoration plantings were highest in diversity of rainforest plants and birds, and also accumulated most above-ground carbon. Therefore designing for biodiversity outcome also maximized carbon benefits per unit area. However these benefits are
achieved at greater cost per hectare, leading to complex spatial and financial trade-offs. Novel reforestation techniques and designs are required to both provide habitat for rainforest biota and store carbon in biomass at lower cost.

La Sierra del Madrigal en Tabasco, México: Banco de germoplasma in situ para especies de Areceaeas en riesgo

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La pérdida de comunidades forestales naturales no sólo ocasiona la pérdida de la biodiversidad, la protección de los suelos y su fertilidad; se pierden además, importantes recursos cuya conservación por parte de las comunidades rurales adyacentes contribuiría al desarrollo de programas de manejo sustentable que las beneficiara social y económicamente. Uno de dichos recursos es representado por las diversas especies de palmas del sotobosque de la Sierra del Madrigal en Tabasco, México, que aun no han sido objeto de un estudio que determine algunos aspectos de su ecología en un fragmento con remanente de selva alta perennifolia que aún permanece inalterado en dicha sierra. Con el objetivo de determinar la riqueza de especies, su abundancia e índice de valor de importancia, se realizó el muestreo de un fragmento de selva alta perennifolia de aproximadamente 4000 ha mediante 50 transectos de 50m x 2 m. Se obtuvo un total de 17 especies, 11 de las cuales se encuentran dentro de la norma mexicana de especies en riesgo y 12 no habían sido reportadas con anterioridad en el sitio de estudio, zona que podría considerarse como uno de los últimos refugios en Tabasco de germoplasma in situ de estas especies y que se encuentra en riesgo permanente ante la deforestación, cambios en el uso del suelo, por sobreexplotación del recurso e incendios.

Estrategias de rehabilitación en comunidades indígenas del trópico seco del Sur de México

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En Guerrero, México, la región Montaña se caracteriza por la predominancia de población indígena, el uso ancestral de los recursos naturales de la región, presentar elevados índices de marginación y agudos problemas de degradación. En 1995 iniciamos estudios en cuatro comunidades de la zona cálida de la región, áreas con predominancia de bosque tropical caducifolio (BTC). En un marco de estudio interdisciplinario las investigaciones se abocaron a desarrollar las etapas del proceso de restauración. Esto permitió identificar el estado del sistema, discernir los factores causales del estado actual, reconocer el valor de uso social y productivo asignado y proponer acciones de rehabilitación. Con los pobladores se decidió colectivamente la necesidad de mantener y recuperar los servicios ambientales de regulación y suministro, por medio de mejorar la estructura y composición de la vegetación para favorecer la dinámica de regeneración y prevenir la degradación del suelo. Se establecieron sistemas agroforestales en parcelas agrícolas en uso y plantaciones en terrenos que ya no se utilizan con este fin; en su establecimiento se utilizaron 22 especies nativas al BTC de la región. Los resultados son promisorios, en los terrenos se reconstruyó una estructura y composición vegetal que actualmente contribuye a atenuar el riesgo de degradación del suelo y a mejorar sus propiedades, pero falta confirmar que los procesos y servicios ambientales estén recuperados y se mantengan en el tiempo.

Electrical fields greatly increase saltmarsh growth and survival and speed restoration even in adverse conditions

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Intertidal saltmarshes are crucial fish and shellfish nurseries, and protect muddy and sandy shores from erosion, but are rapidly vanishing due to coastal development and pollution. Saltmarsh and oyster reef loss are major factors in coastal erosion. Saltmarsh grass, Spartina alterniflora, was grown next to an isolated polluted landfill site in Queens, New York City with and without electrical trickle charges from solar panels. Electrically stimulated Spartina grew 2.2 times taller, had more stems per clump, were darker green in color, and had 22.1 times higher survival over winter than control plants. Measurements with a pulse amplitude modulated fluorometer found higher photosynthetic rates and efficiency of photosystem II, and higher photosynthetic quantum yields in all Spartina electrical treatments. This was despite being grown lower in the intertidal than the lowest limit of nearby natural Spartina populations and in sediments near a Superfund site severely contaminated with hydrocarbons, PCBs, PAHs, and toxic trace metals. These results indicate that electrical stimulation can be used not only to greatly increase saltmarsh growth in restoration sites damaged by oil pollution, such as the Gulf of Mexico, but can also be used to increase Spartina
growth and survival and to extend saltmarshes seaward of their normal limits and reduce coastal erosion. Large scale tests in saltmarsh damaged by oil spills should be conducted in Louisiana and in New York City.

**Electrical stimulation greatly increases oyster survival in restoration projects**

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Coastal Preservation Network, USA

Oyster reefs have suffered massive declines worldwide. New York City once had more than 900 square kilometers of oyster reefs, but now has essentially none left because of over-harvesting. Because oyster filtration is the most effective way to remove sediments, organic matter, and bacteria from coastal waters, New York City’s Green Infrastructure Program is now encouraging oyster reef restoration to clean up water quality, and avoid the need for vastly more expensive water and sewage treatment plants. Oyster reef restoration efforts to date have largely failed due to very low survival of transplants. We are growing oysters in mesh bags in New York City waters with and without trickle charging from solar panels. Young oysters grown in electrical fields under various conditions had very high over-winter survival (mean 79.8%, range 69.2-100.0%) and had shiny white shells. In contrast, control oysters in the same habitat had almost complete mortality (survival 8.4%), and the shells had a red-yellow color and appeared eroded. spat placed in the fall were 30.9+2.71 mm long. Electric oysters had clear growth over the normally dormant winter season (mean length 37.4+5.0 and 39.4+4.0 mm in two separate experiments). In contrast, control oysters shrank in length over the winter to 27.4+2.71 mm. Our results suggest that oyster reef restoration, and improvement of water quality, could be significantly sped up by establishing large oyster nurseries that are trickle charged from solar panels.

**Técnicas de germinación a semillas promisorias para la fitorrremediación de suelos contaminados por hidrocarburos en Tabasco, México**

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El Colegio de la Frontera Sur, México

En la búsqueda de la reforestación y restauración de suelos contaminados por hidrocarburos se realizaron pruebas de germinación de especies promisorias para la fitorrremediación en un vivero experimental, con las condiciones de humedad y sombra al 60 %, necesarias para que las semillas germinen y crezcan sin limitaciones ambientales, utilizando algunos tratamientos pregerminativos de acuerdo a las formas y características morfológicas de la testa de las semillas. Las semillas respondieron de manera diferencial a los tratamientos: con Cedrela odorata (cedro), Swietenia macrophylla (caoba), Tabebuia roseae (macuilis) e Inga inicuil (jicicuil) se obtuvieron tasas de germinación superiores al 80 %. Esta tendencia de estudio muestra claramente que los tratamientos pregerminativos aplicados a estas especies, contribuirán a la conservación de germoplasma nativo, en situ y ex situ, también despertará el interés de los pobladores para utilizar especies nativas con algún beneficio. Pues los tratamientos que se aplicaron presentan una serie de información, necesarias para poner en práctica para remediar suelos contaminados con hidrocarburos.

**Mechanisms involved in the restoration of stream water and habitat quality in a cattle-dominated landscape of Colombia**

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Cattle ranching is an important economic activity in Colombia. It occupies about 38% of the country’s land surface and 77% of the agricultural area mostly at the expense of tropical forests. The deforestation and soil degradation caused by this activity have negatively affected aquatic environments in the Andean region of the country where pastures usually extend to the margins of water bodies thus impacting directly streams and rivers. In order to reduce the impact of cattle ranching on the environment, CIPAV has encouraged farmers to restore riparian corridors in pasture-dominated watersheds. We measured soil properties, runoff, and nutrient retention in riparian areas covered by forests (predominantly giant bamboo *Guadua angustifolia*) and by pastures. Soils in riparian corridors covered by pastures had higher compaction and apparent density, and less porosity and hydraulic retention than soils covered with bamboo (p<0.05). Runoff measured was equivalent to 5% of rainfall in bamboo corridors and 29% in pasture corridors (p=0.05). Bamboo corridors also retained more nutrients than riparian areas covered with pastures. Riparian corridors with forest cover contributed to improve soil physical properties that have influence on water infiltration and retention by the soil. Streams flowing through forested riparian areas had better water quality and provide a more
diverse habitat which was reflected in a more healthy macroinvertebrate fauna. Thus, riparian corridors with bamboo contributed to reduce runoff and nutrients entering the streams.

Effects of non-native plant, *Mikania micrantha* H.B.K., invasion on N cycling

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Sun Yat Sen University, China

Allelopathy has been regarded as a mechanism for successful non-native plant invasion. However, it is not clear if and what effects of allelopathic substances may exert on N cycling. The non-native plant, *Mikania micrantha* H.B.K. (*M. micrantha*), has invaded many forests in south China, and recent studies have suggested it has allelopathic potential for other plants and soil microbial community. Thus, we hypothesized that *M. micrantha* could influence litter decomposition of native plants and soil N transformation through allelopathy. Litter decomposition of native plants and nutrient release, and the changes of soil properties (total C and N, NO$_3^-$, NH$_4^+$ and pH) were measured after treating with different concentrations of aqueous extracts of *M. micrantha* (T1: 0.005 g ml$^{-1}$; T2: 0.025 g ml$^{-1}$; T3: 0.100 g ml$^{-1}$). The extracts increased litter decomposition rate of 5 native plants, while decreased that of *Litsea glutinosa* and *Castanopsis chinensis*. The extracts decreased soil pH, and T1 decreased it the most, and it increased soil C and N, and T1 represented the greatest increase in both C and N. The extracts also increased both NO$_3^-$ and NH$_4^+$ in soil, whereas no significant difference existed among the 3 extract treatments. Compared to the water control, the soil water mineralization rate was higher under T1, while lower under T2 and T3. Our results suggest that the water soluble allelochemicals of *M. micrantha* altered litter nutrient release and improved soil nutrient availability, through which the invasive plant *M. micrantha* may successfully invade and establish in new habitats.

The effect of biological substitute and resource availability variation on invasive plant control and mangrove forest restoration

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Control of the invasive weed *Spartina alterniflora* Loisel has been a hot issue in recent years; however, the most effective way has not yet been found. In this presentation, we discuss a new method, planting *Sonneratia apetala*, an alien fast-growing mangrove. We also discuss the primary mechanism of the asymmetric competition between the two species and the effect of light control on the restoration of native mangrove ecosystems, namely the competition balance between *S. apetala* and native mangrove, *Aegiceras corniculatum*, under different light treatments. Our results showed that 1) *S. apetala* decreased the density, aboveground dry biomass, relative growth rate of *S. alterniflora* by 76.36%, 89.72%, 40.6% respectively; 2) Light intensity was positively related to aboveground dry biomass of *S. alterniflora*; 3) Volatiles and soil extract from *S. apetala* were inhibitorier than those from *S. alterniflora*; 4) The shading treatment significantly reduced *S. apetala*’s height and total biomass by 61.31% and 71.0%, whereas the growth of *A. corniculatum* was not affected. These results suggested that lower light availability and allelopathy inhibition are two of the main reasons for the *S. alterniflora* control by *S. apetala*. Besides, lowering light availability could also inhibit the growth of *S. apetala* and increase the competitiveness of *A. corniculatum*. Manipulating the light availability by controlling the density of planting could be an effective strategy to restore the degraded wetland habitat and reestablish the native mangrove forest.

*Propuesta para la restauración ecológica de los humedales Torca y Guaymaral, Bogotá - Colombia*

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El estudio “diseños conceptuales para la restauración de humedales” se encuentra dentro del proyecto: “Factibilidad técnica, ambiental, económica y financiera para el desarrollo de la infraestructura de acueducto y alcantarillado sanitario y sistema de drenaje pluvial del Borde Norte (área objeto de expansión urbana) de Bogotá”. El objeto fue elaborar una estrategia de restauración (a partir del protocolo de restauración y rehabilitación ecológica de humedales urbanos de Bogotá) para la recuperación integral de las condiciones físicas, ecológicas y paisajísticas de los humedales Torca y Guaymaral que permitan restablecer la provisión de servicios ecosistémicos, recreativos y educativos. Lo anterior teniendo en cuenta que los humedales urbanos de Bogotá son ecossistemas que a través del tiempo han sido severamente degradados y son elementos ecológicos que forman parte de la Estructura Ecológica Principal de Bogotá (decreto 043/2010). En el estudio se realizó un diagnóstico y un análisis multidisciplinario (hidráulico, geológico, geomorfológico, hidrológico, ambiental, paisajístico) a partir del cual, se establecieron bases para la toma de decisiones en cuanto a la estrategia de intervención y los diseños para la recuperación integral de
éstos humedales, dentro de los cuales se encuentran: rehabilitación hidrogeomorfológica, recuperación de comunidades vegetales acuáticas y terrestres, rehabilitación del hábitat para la fauna y ubicación de infraestructura para la recreación pasiva, investigación y educación. Lo anterior permitirá potencializar bienes y servicios actuales de los ecosistemas, eliminar los tensionantes, minimizar los limitantes y con esto proveer a los ecosistemas los componentes necesarios para la recuperación de su función natural de autorregulación y sostenimiento.

Restauración ecológica participativa de la biodiversidad de cuatro complejos de humedal en el Magdalena Medio
Chisacá Hurtado, Magda Liliana
Fundación Alma, Colombia

Los complejos de humedal son sistemas de ciénagas permanentes y/o estacionales, los cuales están siendo fuertemente degradados por la expansión agrícola y ganadera, lo que ha ocasionado modificación de los regímenes hidráulicos, contaminación y eutrofización. Se hace necesario entonces detener y corregir los procesos de degradación, recuperar y socializar los conocimientos tradicionales de los ecosistemas y su manejo, desarrollar herramientas para el comienzo de los complejos y restablecer el potencial para la pesca artesanal y otras formas de uso sostenible de los complejos. Para el logro de lo anterior se plantean dos estrategias complementarias entre sí: mitigación de las causas de la alteración y refuerzo del potencial de regeneración, a través de la restauración ecológica participativa, la cual implica un ejercicio intensivo del diálogo de saberes entre un equipo profesional interdisciplinario y la comunidad local, para la comprensión profunda e integral de los elementos, relaciones y mecánica de la alteración y la regeneración, así como la construcción de una visión común de metas y caminos. Todo lo anterior se realizó a partir de una Evaluación Rápida de Restauración Ecológica, el cual se compone de datos generales del área, descripción del patrón sucesional, causas, mecánica, efectos y estado actual del proceso de alteración, línea base para el monitoreo de la restauración, identificación y calificación de las especies dinamizadoras e indicadoras y definición del potencial y objetivos de la restauración. Como resultado se elaboró un protocolo de restauración ecológica participativa para los complejos de humedales del Magdalena Medio.

Five principles to shoot “moving targets” in ecological restoration under changing environment
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The unpredictability and variability of the nature in the changing environment are a major challenge for ecological restoration because they move the “targets” of restoration continuously. To shoot such “moving targets,” this paper advocates five principles as follows: Firstly, historical information cannot be discarded because it provides crucial guidance for developing the restoration models and goals for the future. Secondly, restoration goals and models need to be flexible and multiple. The dynamic environment of the nature does not warrant a single and fixed restoration outcome. Therefore, the restoration targets need to be multiple, enlarged, and moveable. Thirdly, the contemporary restorations should direct to the future environment and embrace novel ecosystems. The future environment will be different from the past and current one, and thus shifts in species compositions and guilds seem inevitable. Fourthly, for the reason of the third principle, our restoration efforts should focus on rehabilitation of ecosystem functions for the future rather than re-assemblage of floras and faunas of the past. The compositions or guilds of the species in the restored ecosystems need not be identical to the ones in the current and past environment, as long as the novel species fill in the niches (also called functional roles) of contemporary species. Finally, ecological redundancy needs to be magnified for diversifying the goals and trajectories of restoration. Each functional group of ecosystems should consist of multiple and numerous species, not a single species, and various landscape types need to be repeated.

Alternativa socio-económica y ambiental para recuperación de áreas degradadas por la minería de carbón en Santa Catarina, Brasil. Datos preliminares
Citidini Zanette, Vanilde; E. Rocha-Nicoleite, R. Santos, P.R. Neves, S.Z. Custodio, K. Cer0
Universidade do Extremo Sul Catarinense, Brazil

En el estado de Santa Catarina, sur de Brasil, la explotación de carbón ha dado origen a extensas áreas degradadas que están siendo recuperadas con diversas finalidades. No todas estas áreas son de propiedad de la empresa minera, la cual tiene el deber de recuperarlas de acuerdo con disposiciones de organismos ambientales. En algunos casos existen divergencias entre los propietarios y esas empresas con relación a la recuperación del área ya sea por restricciones técnicas o ambientales. Existen conflictos sociales entre la empresa y la comunidad, que desea utilizar
Recuperación de áreas de explotación mineral a cielo abierto en la región carbonífera de Santa Catarina, Brasil

Citadini Zanette, Vanilde
Universidade do Extremo Sul Catarinense, Brazil

El proyecto “Recuperación Piloto de Áreas Explotadas a Cielo Abierto” (PRP), implementado en Siderópolis, Santa Catarina, Brasil (28° 35’ S y 49° 25’ W, 160 m de altitud) en 1982, constituyó un hito en la explotación de carbón por ser el primero a ser realizado en la región con el objetivo de verificar la viabilidad de recuperación de áreas degradadas. Fue realizado en un área de 11,4 hectáreas, donde fueron testadas 12 especies de árboles en 12 macro parcelas dispuestas en tres áreas experimentales de 7,200 m2 cada una, mediante diferentes tratamientos de fertilización. Paralelamente cinco especies herbáceas (gramíneas y leguminosas) fueron introducidas por hidrosiembra. Después de 22 años fue evaluada la regeneración natural del subbosque de bracatinga (*Mimosa scabrella* Benth.), única especie nativa de Brasil que sobrevivió y presentó buen desarrollo en la búsqueda de auxiliar a la recuperación de áreas degradadas en la región. Un estudio fitosociológico fue realizado en 1.800 m2 de área donde la vegetación fue separada en dos grupos: especies arbustivo-arbóreas, incluyendo los individuos con más de 20 cm de altura y especies herbáceas terrícolas y lianas. Fue evaluada la similitud florística con estudios realizados en remanecientes forestales próximas y, registradas las categorías sucesionales, estrategias de polinización y de dispersión de las especies. Los resultados fueron sorprendentes y adecuados para recuperar áreas de carbón explotadas a cielo abierto, dada la regeneración natural ocurrida en el sub-bosque de *M. scabrella*, recomendándose el uso de esa especie en la fase inicial de proyectos de recuperación ambiental.

Institutional limitations prevent practice-science collaboration

Clewell, Andre
Tall Timbers Research Station, USA

The gap between practice and science cannot be closed without institutional reform. Ecologists cannot collaborate directly with practitioners without risking advancement in their careers, because institutional mechanisms within universities have not evolved to foster collaboration. Most practitioners are engaged by government and transnational institutions which administer public lands and conduct public works projects. Nearly all practitioners are beholden to conditions imposed in permits issued by government institutions. Relative to ecological restoration, most government and transnational institutions undervalue the importance of ecosystem structure, confuse ecosystem function with social services, give lip service to sustainability, and ignore a historic reference as the starting point for design. Since these institutions also sponsor research in restoration ecology, they compromise both practice and science. Closing the divide between practice and science will require concomitant institutional enlightenment and reform. The situation is not intractable and will resolve as the meaning and promise of restoration become more widely realized.

Gender and ecological restoration: Let women do the job!

Cliquet, An; N. Broekhoven
Ghent University, Belgium

Scientific literature and policy documents acknowledge a clear linkage between gender and conservation and sustainable use of biodiversity, especially in developing countries. After illustrating the important role that women play in biodiversity conservation and ecological restoration, we will mainly focus on legal perspectives of women and ecological restoration. The role of women in conservation and sustainable use of biodiversity and the need for full participation of women at all levels of policymaking and implementation for biodiversity conservation have been recognized in several legal documents, such as the Biodiversity Convention. However, there is a huge lack of
implementation of these international engagements. Most policy and legal documents rarely translate into action, there is a lack of monitoring and there is no enforcement. Most of the international engagements are included in ‘soft’ law instruments. The explicit reference to the link between women and conservation is largely missing on the national and local level. In order to increase the involvement and participation of women in biodiversity conservation and restoration further steps are necessary. From a legal perspective two tracks are suggested. On the one hand, the provisions on women and conservation in environmental law instruments should be upgraded towards harder and more concrete legal obligations. On the other hand, a human rights-based approach towards conservation already provides a legal basis for a larger involvement of women in conservation and restoration projects, including procedural rights such as the right to participation in decision-making.

**Incorporating socioeconomic factors into restoration: Implications from industrially harvested peatlands**

Collier, Marcus
University College Cork, Ireland

In establishing effective restoration goals one of the four key issues of increased attention that Richard Hobbs calls for is in the area of incorporating socio-economic investigations and theories into restoration practice in a synergistic manner. While often commented upon by restoration practitioners, this is an area of research that is poorly developed, and since it relies on an uneasy combination of empirical and interpretative research methodologies a multidisciplinary alignment may be problematic in practice. This opinion piece is drawn from experiences in examining the after-use of industrially mined peatland landscapes, and synthesizes ideas that have emerged from socio-economic research over several years in order to offer an opinion on how Hobbs’ call may be addressed. Because socio-economic concerns are at the root of all restoration projects, sociological methods may be useful as tools in stakeholder engagement in research and planning for landscape rehabilitation as a mechanism for reducing the potential for conflict and for facilitating participative or collaborative restoration.

**Eden3: Empathic experience with trees.**

Collins, Timothy; R. Goto
Collins and Goto Studio, USA

‘Eden3: The Ethical Aesthetic Impulse’ is the title of an artist led research initiative which explores the potentials and pitfalls of developing a sculptural interface, that enables empathic exchange with trees as they react to ever changing atmospheric chemistry and climate in cities. Reiko Goto and Tim Collins articulate the challenges, success and failure as they develop a material/process model of exchange and non-verbal, empathic communication across species. Work on ‘Eden3: The Secret Life of Trees’ was initiated in 2008, the artists intend to make a contribution to the perception, experience and understanding of the relationship between trees and a greenhouse gas (CO2) in cities. The intent of the project is to reveal a tree’s role in atmospheric exchange, while trying to understand the potential for empathy, and its relationship to imaginative and responsible human response. The research was initiated in 2008 after consideration of free air carbon exchange experiments in the USA. An operational sculptural system has been developed with the support of a technologist and musicians; the ‘Eden3: Plein Air’ artist easel, features sensors and software that allow the audience to hear the sound of physiological reaction (scientifically accurate photosynthesis data) as one leaf adjusts to surprisingly fine grain anthropogenic changes in ground level atmospheric chemistry. Another system, the ‘Eden3: Climate, Tree Porter’ is currently under development. Based on breath as a metaphor, the system is being designed around oxygen and carbon dioxide sensors. The ‘Climate, Tree Porter’ is planned as a low cost portable alternative to ‘Plein Air.’ In the former system the audience listens to two trees as they react to ever changing chemical and atmospheric exchange, in the latter the performer ‘plays’ trees (as a musician uses an instrument) to enable perception of atmospheric exchange (the breathing of trees.)

**Ecological restoration of the Western-Negev dune system in light of land-use changes: Aeolian activity and faunal responses**

Columbus, Udi; Y. Ziv, B. Gurion, H. Tsoar
Ben Gurion University, Israel

For the last 3 decades, the western-Negev dunes system has been undergoing a stabilization process in which shifting dunes gradually become stable and covered by biogenic soil-crust. This stabilization process occurs due to a change in land use, i.e., the lack of Bedouin activity (trampling, grazing, wood collection), since Israel withdrew from Sinai in 1982. Thus, we are currently loosing important shifting-sands habitat as well as the overall habitat heterogeneity.
Consequently, we witness a change in the structure and composition of faunal communities inhabiting the dunes. This is especially true for the rare, endemic and endangered psammophilic species, which depend on the shifting-sands habitat for reproduction and survival. In order to reanimate Aeolian activity and subsequently restore the shifting-sand habitat, in June 2010 we broke biogenic soil-crust and partially removed vegetation on an extensive area on 8 different dunes, each having a manipulation and control plot. Following these large-scale manipulations, we monitored changes in the physical environment and the response of reptiles, rodents and ground beetles to these changes. Our current results show that sand mobility has increased significantly on manipulated plots. Faunal communities have shown diverse responses, with some species displaying increased population size while others decline, partially based on their affinity to shifting sands. As time passes, the biogenic soil-crust re-establishes on the dunes and new patterns are revealed. In turn, this suggests that active management is needed to keep the restoration efforts in place and that additional monitoring is required for future conclusion.

**Perspective on the evolution of the changing approaches for the restoration of opencast mines**

Comín, Francisco A.; J. M. Nicolau, S. Pérez, M. Trabucchi, L. Miguel

Instituto Pirenaico de Ecología, Spain

The changes in the approaches to restore opencast coal mines observed in NE Spain and in other sites can be grouped in restoration generations. The first generation (1980s) was characterized by the idea of accumulating materials in the hole of the mined area. It initiated by using the model platform-slope-berm which has the advantage of accumulating high amounts of material but with differences of stability if the slope is higher or lower than 22º. This mine restoration practice has not much control of the water in the berms and it depends on the development of vegetation in the slopes. The second generation of restoration (1990s) incorporated at small scale the construction of relief forms simulating some natural areas as inspiring forms. The landscape recovers heterogeneity at some areas of the mine but still preferential areas of water flow created by accident cause terrain instability and low water quality in areas of water accumulation, particularly if this is not followed by a management plan. The third generation involves the application of constructed systems (check dams, wetlands) to reduce solid transport by water run-off. A fourth generation has been initiated by reconstructing the whole catchment and mine basin estimating system characteristics from natural drainage systems. A next generation is proposed to involve local people participation for incorporating both their traditional knowledge and their expectancies. This perspective on restoration advances can be extended to other open mines and sites strongly influenced by extractive activities.

**Improving seed quality, storage and germination for arid zone restoration**

Commander, Lucy; D. Merritt, K. Dixon

Kings Park and Botanic Garden, Australia

Over 20,000 ha of arid zone vegetation in northwestern Australia has been disturbed by mining. To restore biodiverse plant communities, use of topsoil, broadcast seeds and/or seedlings is necessary. But with a limited amount of topsoil, the expense of seedlings and the area of disturbed land, most restoration in this region must be via direct seeding. Currently, limited knowledge of seed traits is hampering restoration efforts. Seed testing indicated many species have low seed quality, which contributes to an under-representation in restored areas. For instance, seed fill for one seed batch was 46%, viability 16% and germination 11%. Viability loss likely resulted from inappropriate storage conditions. To better inform seed banking procedures, rapid aging techniques were used to evaluate potential storage longevity. Most species appear relatively long-lived and seeds from hot environments have greater longevity than those from cooler regions. Seedling emergence in restoration sites is <15%, and research is focused on seed germination ecology, particularly responses to water and fire-related cues (smoke), to increase seedling establishment. Under optimal moisture conditions, non-dormant seeds germinate quickly (time to 50% germination is <3 days), however, germination percentage and rate differ between species when moisture is limiting, and may explain differences in field emergence. Smoke stimulates fresh seed germination (11 species in 5 families), and there is a relationship between smoke and dormancy status, for some species, smoke is always required for germination, whereas for others, different mechanisms of dormancy release, such as dry storage, alleviate the need for smoke.

**Estructura, diversidad y procesos ecológicos de tres coberturas con modos contrastantes de restauración en el premontano y montano bajo de Costa Rica**

Cordero Sólórzano, Roberto A.; T. Bermúdez, F. A. A. Garrido, J.L. Chávez

Universidad Nacional de Costa Rica
Con el objetivo de comparar el éxito de la restauración forestal a nivel ecosistémico, hemos medido la estructura del dosel (Índice de Área Foliar, IAF), la riqueza de especies leñosas y de líquenes, las lombrices del suelo, y la caída, cantidad y descomposición de mantillo, en tres sitios con coberturas vegetales con diferente edad y modo de restauración: un tacotal (Ta, finca con 13 años de abandono), un cipresal (Ci, 35-40 años) y el bosque maduro como referencia (Br, >50 años), del Valle Central Oriental de Costa Rica, en 50 parcelas contiguas de 100 m² por sitio. Encontramos que el IAF aumenta del Br>Ci>Ta. La riqueza de leñosas (>10cm DAP) del cipresal es el doble (31 especies) que en el tacotal (16 especies) y solo dos tercios de la riqueza del Br. La riqueza de líquenes, muestreada al azar sobre 200 cm² del tallo fue de 44 (Ta), 23 (Ci) y 22 (Br) especies, pero su cobertura es mayor en el Br que en Ta y Ci. La cantidad de hojarasca producida fue similar. La densidad de lombrices es menor en Br y se asocia a suelos muy húmedos y bajo pH. El Ci acumula tanto mantillo como el bosque pero es más compacto. La descomposición fue menor en Ta. La inclusión de los parámetros sobre diversidad, estructura del dosel y varios procesos ecosistémicos nos permiten determinar de manera más integral el éxito de cada modo de restauración y su contribución relativa en servicios ambientales, como el secuestro de carbono.

**Ecological-economic impacts of ecosystem restoration in the Seine estuary: An application of a regional integrated Input-Output model**

Cordier, Mateo; J.A. Pérez Agüídez, M. O’Connor, W. Hecq  
CEEE-ULB, Belgium

An integrated Input-Output model is developed to assess environmental and economic impacts of the restoration of 25% of sand-flat nurseries with high sole density lost in the Seine estuary between 1834 and 2004. Three scenarios are tested to simulate the state of the anthropo-ecosystem in 2015: i) a BAU scenario (Business As Usual) that follows the ongoing trend without restoration measures, ii) a scenario with restoration costs taken in charge by the sectors that are directly responsible of nursery destruction (harbors) and iii) a scenario with restoration costs shared between sectors prorated to the amount of goods transported by boat (given that water transport infrastructures are one of the main causes of nursery destructions). Two ecosystem services have been considered: 1) life support service ensured by nursery habitats for juveniles of Soleasolea (common sole); 2) halieutic resources available for human consumption. Our results show that the restoration of a total of 24.38 km² of subtidal nursery areas over the period 2004-2015 would result in a stock of sole in 2015 that exceeds the BAU scenario by 18.5%. The economic results show that this large nursery restoration programme generates significant negative economic impacts at the sector level but only a slight negative impact at the macro-economic one (GDP in restoration scenarios is 0.3% lower than in the BAU scenario). This suggests that the restoration costs can be seen more as a problem of cost allocation than as a problem per se.

**Restauración ecológica de Xochimilco y Pátzcuaro mediante la caracterización de sus estructuras tróficas**

Cordova Tapia, Fernando; Elsa Leticia Valiente Riveros, Ángel Merlo Galeazzi, Luis Zambrano González  
Instituto de Biología, UNAM, Mexico

Para llevar a cabo la restauración ecológica de un sistema acuático, es necesario caracterizar su estructura trófica, conocer el grado de contaminación y los efectos del cambio de uso de suelo en las riberas. Con ello es posible implementar programas de biomanipulación o de mejoramiento de la calidad del agua. Xochimilco y Pátzcuaro son dos sistemas dulceacuícolas perturbados que aún cuentan con poblaciones de especies endémicas de vertebrados y que son susceptibles a restauración. Hemos utilizado el análisis de isótopos estables de carbono y nitrógeno para caracterizar sus estructuras tróficas, con el objetivo de conocer las relaciones que existen entre el cambio de uso de suelo, la calidad del agua, la abundancia de especies exóticas de peces y la presencia de especies nativas. En ambos sistemas, las especies exóticas presentaron un traslape de nicho trófico con las especies nativas de peces. La calidad del agua y la presencia de especies exóticas se relacionaron con la pérdida de diversidad trófica en la base del sistema, así como con el cambio de uso de suelo. Estos trabajos sientan las bases para el diseño y desarrollo de programas de restauración ecológica con el fin de promover condiciones tróficas favorables para las especies nativas mediante la expansión de la diversidad trófica en la base del sistema.

**Establishing marine protected areas: A comparison of strategies in four different states in Australia**

Corpuz, Ember Catherine  
Flinders University of South Australia
La restauración de cuencas hidrográficas constituye un ejercicio complejo, en el cual la inversión económica y de recursos humanos es intensa y larga en el tiempo. La trama institucional en México determina que los procesos de colaboración y coordinación necesarios para la restauración de estos territorios complejos sean incipientes. Por ello, a nivel nacional, era necesario identificar las cuencas hidrográficas que requieren la intervención colaborativa del gobierno para recuperar su estructura y funciones. Sin embargo, la obtención de una imagen clara de la condición de las cuencas no es siempre sencilla, dado que los datos son limitados y las perspectivas sobre la manera de evaluar su estado son distintas entre las diferentes instituciones. A partir del diagnóstico de las cuencas de México, se seleccionaron algunos indicadores que muestran la alteración del funcionamiento eco-hidrológico, como son: el índice de transformación humana de los ecosistemas, degradación de suelos, fragmentación de ríos y deterioro de zonas riparias, presión hídrica y contaminación potencial difusa. Bajo el contexto de análisis espacial multi-criterio estos indicadores se estandarizaron y ponderaron. Posteriormente se integraron con indicadores que expresan el nivel de presión a la cual están sujetas las cuencas, a través del crecimiento proyectado de la población al 2030 y las tendencias de cambio de uso de suelo. Los resultados obtenidos reflejan la importancia de contar con una priorización de cuencas para planear y dirigir correctamente el esfuerzo gubernamental.

**Conocimiento y capacidad organizativa para la conservación de suelos en México**

*Cotler Avalos, Helena*

Instituto Nacional de Ecología, México

Los suelos constituyen continuos en el paisaje, cuyo manejo puede proporcionar servicios o diservicios ambientales a diferentes escalas espaco-temporales, originando externalidades negativas en el sitio de origen y fuera de él. Los sistemas de producción agropecuarios y forestales siempre han incorporado prácticas que mantienen la funcionalidad de los suelos y con ello su calidad. Sin embargo, el grado de degradación actual señala una ruptura en estas prácticas. Algunas de las variables explicativas podrían ser el grado de conocimiento sobre la resistencia y resiliencia de los suelos y la capacidad organizativa de las comunidades para establecer formas de colaboración con autoridades gubernamentales. Mediante 60 entrevistas semi-estructuradas en ejidos del centro del México se identificaron indicadores locales de la degradación de suelos. Asimismo se identificaron las relaciones que se establecen entre las comunidades y el gobierno mediante (i) la respuesta de los usuarios ante el programa de conservación de suelo a nivel federal y (ii) el grado de aceptación y la replicabilidad de las obras entre los usuarios. Los principales resultados muestran que los indicadores son sitio-específicos y expresan un conocimiento sobre el funcionamiento de los suelos y su resiliencia. Asimismo señalan la debilidad institucional de los ejidos para la planeación de sus bienes comunes, en términos de la posibilidad de asociarse, establecer reglas claras y sanciones o buscar alternativas que permitan un mejor aprovechamiento de sus recursos. También se discute la relación entre el tipo de acciones de conservación de suelos y la facilidad de replicabilidad por parte de los usuarios.
Establishment of stem and root stakes of dry forest's tree species under different treatments
Coutinho, André; D. de Oliveira Rodrigues, D. L. M. Vieira
University of Brasilia, Brazil

Large tree stakes would be recommended to make live fences and restore the landscape of dry forests of Central Brazil, once it is dominated by pastures. However it is not known what species can sprout from stakes in Central Brazil. We tested the success of stem (2m long) and root (30 cm long) stakes of dry forest tree species in a greenhouse, simulating the precipitation from the dry forests. Four treatments were tested for stem stakes: (1) collection and planting in the dry season; (2) collection in the dry season and planting in the wet season, before storing in moist soil; collection and planting in the wet season (3) with or (4) without NAA hormone. Root stakes were collected and planted in the dry season with or without hormone. Anadenanthera colubrina, Aspidosperma subinicanum, Astronium fraxinifolium, Myracrodruon urundeuva and Tabebuia impetiginosa were tested as stem and root, Dipteryx alata as stem, Eugenia dysenterica as root only. Species selection was based on high density of treelets in early secondary forests and root resprouters in ploughed areas (source of stakes). We recorded branch growth and root and stem biomass. Success was considered when stakes presented roots. None of the root stakes produced new roots. Only 3% of stem stakes were successful. M. urundeuva had the best results, with 23% of success in treatment 1. Thus, posterior studies with long stakes should further explore M. urundeuva, besides testing dry forest species with good resprouter congeneric species in Central America, such as Spondias mombin and Erythrina sp

How can we use trait-filter models to improve restoration practices?
Craig, Michael; L. Lach, V. Stokes, G. Hardy, R. Hobbs, P. Kennedy
Murdoch University/University of Western Australia

It is becoming increasingly apparent that simply establishing vegetation will not ensure that all fauna will naturally recolonise restored sites. This implies that modification to restoration practices are required to facilitate faunal recolonisation. Given the critical role that fauna play in ecosystems, facilitating faunal return is also likely to increase restoration success in many cases. One of the reasons why fauna are rarely considered when designing restoration programs is the lack of a general understanding of which species are slow, or fail, to recolonise and what restoration practices can be implemented to facilitate their recolonisation. We propose that trait-filter models provide a fertile theoretical framework for identifying the ecological characteristics, or traits, of species that are slow, or fail, to recolonise restored areas. By identifying these traits, we can then identify the barriers, or filters, present in restored sites that prevent recolonisation by certain species. In turn, we can modify restoration practices to remove, or minimise, the effects of these filters. We present a series of testable hypotheses that represent the likely filters to faunal recolonisation that exist in most ecosystems. However, the ecological traits that predispose fauna to these filters are unclear in many cases, so future testing of these hypotheses is required to identify these ecological traits and determine how prevalent these filters are across ecosystems. We encourage the development of restoration practices that facilitate faunal recolonisation is they are likely to increase the resilience and biodiversity value of restored sites.

Natural and cultural restoration projects of the Washoe Tribe
Cruz, Darrel
Washoe Tribe, USA

The focus of this session are examples of the Natural and Cultural Restoration Projects of the Washoe Tribe and what we are doing to protect, preserve and restore the natural and cultural environments. Our people have been part of the environment and reliant on the landscape for all their needs for thousands of years. The tribe has worked on restoration projects that enhance and protect the environment and promote cultural uses. The tribe has established agreements and partnering with federal, state and local organizations to promote Traditional Cultural Properties, designated cultural landscapes on tribal lands, plant gathering areas; work with neighboring tribes to promote cultural exchange activities, reintroduction of native plant and animal species, worked to remove invasive species. We are the lead trustee in a Superfund cleanup of a mine site to restore the environment, watershed, rivers and cultural environment. We establish law and order codes to allow traditional hunting on tribal lands and are working with state agencies to allow traditional fishing practices. We continuously work with educational groups to promote cultural and ecological preservation. We are managing lands in the U.S. Forest Service to promote Washoe traditional cultural and ecological management techniques through traditional ecological knowledge. We are encouraging the use of natural fire as a restoration management tool in the ecosystem. We use native and local seed sources to
Rehabilitate disturbed landscapes. We conduct consultation practices with organizations to protect and preserve the natural and cultural environments and contribute comments to federal and state agencies in planning documents.

Reconciling fuelwood extraction and forest restoration: Potentials of “energetic forests” to improve restoration efforts of a biodiversity hotspot

da Silva Specht, Maria Joana; C. L. Barbosa; S. R. R. Pinto; M. Tabarelli; F. P. Lopes de Melo
Universidade Federal de Pernambuco, Brazil

Natural ecosystems provide environmental goods and services to human survival. The Atlantic Forest of northeastern Brazil is an important biodiversity hotspot where less than 12% of original forest as small isolated forest patches embedded into agricultural landscapes. Additionally, this region presents levels of human density with more than 200 hab/km² and many of these people rely on firewood for supplying their energy demands. Our surveys suggest that each rural families in poor conditions (<4 USD/person/day) need in average 2.7 tons of fuelwood per year, meaning approximately 0.01 hectares of native forest, to supply their demand for cooking. Considering the rural population in this region, if matches this criteria of fuelwood consumption, we predict the loss of 12.40781 tons of wood, equivalent to 5.442 ha of forests diffusely depleted every year. This scenario, however, represents a good opportunity for the establishment of energetic forests (planted and managed native forests) that would supply fuelwood, deviating pressure from natural forest remnants, and helping to enhance forest cover locally. Energetic forests should be a good opportunity to combine forest restoration with environmental goods and services that mitigate poverty and could be the preferable management type for planted forests in regions where fuelwood is the main energetic source for rural people.

Integrating climate change with land-use change

Oak Ridge National Laboratory, USA

Landscape patterns and processes are altered by both resource management and changing climate conditions. Dominant land-management activities involve energy, and use of fossil energy is one of the key drivers behind increasing greenhouse gas emissions and resulting climate change as well as land-use changes. Alternative energy sources (such as wind, solar, nuclear, and bioenergy) are being explored to reduce greenhouse gas emission rates. Yet, energy production, including alternative-energy options, affects land productivity, surface cover, albedo, and other factors that affect carbon, water, energy fluxes and climate. Meanwhile, climate influences the potential output, relative efficiencies, and sustainability of energy sources. Thus, land use, climate change, and energy choices are linked, and any comprehensive analysis in conservation ecology that considers one of these factors should be cognizant of these interactions. Model projections suggest that both climate and land-use changes have large effects on forest biomass and composition in the Cumberland forests of Tennessee and Kentucky. These forests have high levels of diversity, ecological importance, land-use changes, and pressures due to invasive herbivorous insects and climate change. Projections show that climate changes can instigate decline in forest stand biomass and then recovery as forest species composition shifts. In addition, a landscape model suggests that land-cover changes can be quite large and can cause a decline not only in the area of forested lands but also in the size and number of large contiguous forest patches that are necessary habitat for many forest species characteristic of the Cumberlands.

Introduction of Bioshafts™ for the creation of vertical watersheds

D’Alessandro, Domenico
D’Alessandro & Associates, USA

By 2015 more than 600 million people will live in urban centers worldwide. Open spaces in urban centers are not sufficient to counteract the negative environmental footprint. The urban substrate is often a toxic environment that makes percolating runoff hazardous for water quality impacts to shallow aquifers. Surface runoff is vulnerable to all the various debris and chemical pollution of street traffic, and salinity from winter road maintenance in the northern climates. Typical municipal sewage contains disease-causing pathogens and hundreds of highly toxic chemicals. The United States Environmental Protection Agency estimates that 1.3 trillion gallons of raw sewage are dumped by CSOs each year in the US. I propose redefining urban watersheds through the creation of vertical watersheds, composed of bioshafts™ designed for maximum water capacity and high evapotranspiration. They allow above ground retention of water for extended time, reducing storm runoff peak times or eliminating them altogether. Bioshafts™ facilitate introduction of deep rooted plants and enhanced biomass for carbon sequestration. Vertical watershed complexes can function as localized energy producers and water treatment facilities fostering a
decentralized, off-grid, regenerative alternative solution that diminishes water consumption and energy waste. Bio-shafts are easily incorporated into new construction, highly suited to retrofit existing buildings in tight urban situations and brownfield redevelopment. Tying the bioshafts™ to green roofs and extending them into urban rivers would form biological links that are otherwise unattainable in harsh urban environments. Vertical watersheds improve green roof functions, facilitate blue roof applications and form urban habitat corridors for migratory species.

**Seedling selection for restoration success in temperate forests**

*Davis, Anthony*

University of Idaho, USA

Effective use of seedlings is critical to ensuring restoration success. Myriad components including initial seedling cost, availability of plant material, genetic resource management, plant size, cost of planting, and understanding limiting factors on the outplanting site can individually or compound to determine success or failure. This presentation examines some of the decision-making criteria needed to maintain an effective restoration planting program in light of biological, cost, and environmental constraints. Examples are drawn from the Central Hardwood Forest Region and Intermountain West of the United States.

**Utilidad de las áreas naturales protegidas como herramientas de restauración ecológica en áreas metropolitanas**

*de Lucio Fernández, José Vicente*

Universidad de Alcalá, Spain

La mitad de la población mundial habita en ciudades. Las áreas metropolitanas se extienden por el territorio encapsulando ambientes naturales y espacios agrarios. Tales áreas suburbanas tienden a ser marginadas y consideradas áreas de conservación de segunda categoría. Sin embargo esta valoración es terriblemente injusta si tomamos en cuenta la contribución de estos espacios a la provisión de bienes y servicios ecosistémicos. Las áreas protegidas vinculadas a áreas urbanas tienen particular relevancia como proveedoras de servicios ecosistémicos de regulación (agua, clima, fenómenos climáticos adversos) y culturales (accesibilidad para los ciudadanos). Podemos observar que numerosas áreas protegidas han sido creadas en este contexto de regiones densamente pobladas con el objetivo de contrarrestar o paliar los efectos destructores de la expansión urbana hasta el punto de que todas las grandes urbes tienen sus áreas naturales protegidas de referencia. En estas áreas la superficie dedicada a la conservación compite con la expansión urbana. Uno de los factores que más afectan a la conservación es el asamiento de estos espacios inmersos en una matriz metropolitana. Contrarrestar la fragmentación del ecosistema natural mediante elementos conectivos es una de las principales tareas a realizar en la implantación de estos espacios. En nuestro trabajo se presenta las áreas protegidas como instrumento de restauración ecológica en áreas sometidas a una elevada presión poblacional cuantificando los beneficios obtenidos. Se identifican las mejores experiencias y las claves de éxito; así como las consecuencias de las distintas medidas utilizadas para procurar la restauración por medios activos y pasivos.

**‘Top-down’ and ‘bottom-up’ approaches to minimize scale mismatch between ecosystem processes and ecological restoration**

*de Torre Ceijas, Racío; R. Torrel, M.D. Jiménez, S. Magro, I. Mola, J.M. Arenas, A. Vázquez, M.A. Casado, L. Balaguer*

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Cross-scale processes, such as global change, landscape heterogeneity historic legacies, dispersal limitation, colonization and recruitment are fundamental drivers of ecosystem structure and function. Restoration ecology prioritizes repair of ecological processes that lead to recovery of functionality in disturbed environments. Key processes operate at multiple spatio-temporal scales, however, restoration efforts are frequently focused on small sized areas with a local scope. Likewise, monitoring of restoration measurements is commonly too short to include the full cycle of a process. The aim of this study is to highlight the importance of across scale approach for a suitable integration between restoration management and ecological functioning. We illustrate this discussion with our experience from punctual actions, planting clump of woody species in predominant agricultural landscape to enhance structural features at local scale. These restoration actions failed to restore seed dispersal processes at landscape scale. This is due to the historical scarce of dispersers that link patches in this anthropogenic landscapes. Besides, a lack of funding limit monitoring time period. This time may be insufficient to evaluate restoration actions on processes, as well as to apply a properly adaptive management through review goals or adapt technology and treatments. This sort of setbacks evidence the need for rooting ecological restoration in a ‘top-down’ and ‘bottom-up’
diagnosis of ecological processes. We suggest the application of an approach that allows us to assess the influence of large scale on located restoration treatments and simultaneously considering the effects of local measurements on cross-scale processes.

**Remeandering and ecological restoration of a lowland stream in Belgium**

De Vocht, Alain; Sarah Descamps

University Hasselt, Belgium

Most lowland streams in Belgium have been normalized and rectified in the 20th century. In spring 2006 a 2 km long stretch of the Witte Nete, was diverted because of sand mining activities. Populations of endangered fish species Bullhead (Cottus perifretum) and Spined loach (Cobitis taenia) are present and the downstream reach of the stream forms part of the European Nature 2000 network. Apart of the restoration of the meandering pattern with a sinuosity of 1.2, sediment and reed rhizomes from the former reach were used to restore the new stretch. Post-evaluation of the ecological restoration started in 2006 and is still continuous. River morphology, macrophytes, invertebrate and fish communities are monitored in reference sites and the restored stream. Bank erosion and sedimentation of sand bars started soon in a part of the restored stream. The new reach differs from the reference transects in the presence of shallow zones along the banks and a higher variability in water velocity and depth. Macrophytes dominate the new reach after two years and weed management is still carried out yearly. The macro-invertebrate fauna was re-established to a normal level after one year, reaching the highest quality level possible. Species composition of the fish community shows the same diversity as the reference transects. Both Bullhead and Spined loach spontaneously colonized the new reach in less than six months and population size in Bullhead is rising but does not reach the same density as in the reference sites.

**Restoring landfill covers in to Natura 2000 habitats**

De Vocht, Alain

University Hasselt, Belgium

In Europe some landfills are located within the Natura 2000 network. Setting appropriate goals and management actions are necessary in order to achieve sustainable habitat rehabilitation. On the 136 ha large Remo-site the possibilities for the development of heath and dry grassland vegetations has been investigated. Soil characteristics pH-H2O, pH-KCl, organic matter, NO3-, NH4+, total N and P-PO4- were determined. The vegetation was inventorised and plant abundance scored on Tansley scale. The proportion of open substrate, lichens (Cladonia and Cladina species), tree coverage, dry heath (Calluna vulgaris), broom (Serothamnus scoparius), purple moor grass (Molina caerulea), wavy hair-grass (Deschampsia flexuosa) did not differ significantly between reference and landfill sites. Substrate on the landfills was mostly loamy sand while sandy soils were found in reference sites. pH-H2O, pH-KCl, NH4+, and P-PO43- in landfill cover was significant higher than in reference soils. The loamy sandy texture of the landfill cover opens perspectives for a more divers vegetation with elements of dry heaths, dry silecious grasslands or species rich heaths. Appropriate management that is carried out now includes control of tree growth and sheep grazing is used to restore Habitat and Bird Directive habitats.

**Mediterranean pine plantations: Pitfalls and opportunities as restoration tools**

de Zavala Gironés, Miguel Ángel; P. R. Benito, A. de Henares, L. G. Aparicio, A. de Henares

CIFOR-INIA, Spain

There is an increasing concern regarding conversion of planted forest into more natural ecosystems, particularly in the Mediterranean Basin where planted pines covered million of hectares. We conducted an assessment of Mediterranean pine plantations over the continental Spain to determine key ecological characteristics that differentiate them from natural forest, and explore their effect on recruitment and species richness patterns to aid restoration guidelines. Firstly, we conducted a multivariate comparison of ecological variables in planted and natural stands for main Iberian pine species. Secondly, we fitted species-specific statistical models of recruitment and woody species richness to explore how varied among stand types (planted vs. natural) along environmental and stand structure gradients. Iberian planted pine forests occurred on average on sites which differ in their edaphic conditions (poorer and rocky soils), exhibit different perturbation regimes (higher fire frequencies and harvesting rates) and structural characteristics (higher stand tree densities and even aged stands) with respect to natural pine forests. Planted stands showed a lower recruitment and woody species richness than natural forests, with all these differences being more pronounced for P. nigra and P. sylvestris stands. The differences observed suggest the need to develop specific actions to redirect these planted forests towards a different state, more similar to those of natural forests.
Suggested management actions include: at the landscape level naturalization of mountain pines, at the community level, enrichment planting, and at the stand level implement silvicultural systems that enhance structural heterogeneity, chiefly a lower density and an uneven aged structure.

**Narrative skills: Essential tools for all writers**

Dean, Barbara  
Island Press, USA

In order to accomplish the goals and teach the skills of restoration, restorationists need to reach out not only to general audiences such as community groups, students, and town councils, but also to professionals and researchers in related fields. In this session, we will explore how narrative skills can make communication to all these audiences more effective. Narrative skills—knowing how to pique interest, connect with your reader, build suspense—are an asset for every writer, not just novelists. Personal narratives clearly benefit from a storytelling sense, but so does science writing. Developing a cogent argument is a narrative skill: starting from the understanding that your reader has (making a connection), you lead her through new ideas and viewpoints step by step (building intellectual suspense), and arrive at a finale that completes and/or transcends the starting point (delivering emotional and/or intellectual pleasure or benefit). In the new (2011) world of publishing, the opportunities for writers are more numerous and varied than ever—and developing a good narrative sense broadens your options. Depending on what you want to say and what audience you want to reach, you may write blogs, e-shorts, or books printed in ink on paper. We will explore the possibilities and discuss how to apply narrative skills to whatever forms and purposes you choose.

**Wetland restoration in the densely populated region of Flanders (Belgium): Potentials and effectiveness**

Decler, Kris; J. Wouters  
Research Institute for Nature and Forest, Belgium

Flanders is a rich and densely populated region in the northern part of Belgium. Together with the Netherlands it is known as ‘the low countries’ of Western Europe and, by nature, it therefore used to contain a large surface of wetlands. However, for centuries man has strived to drain and cultivate these wetlands as much as possible. This resulted in a restricted surface of remaining wetlands on the one hand, but on the other hand increasing attempts nowadays to restore them for nature conservation and ecosystem services. We developed a GIS method to detect priority zones for wetland restoration and discuss the potentials for different wetland types. Additionally we present the results of a SWOT analysis of the most important, recently executed large wetland restoration projects in Flanders.

**Impacts of fisheries, governance and climate in Latin American shellfishes, and potential actions for restoration strategies**

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In Latin America (LA), artisanal shellfisheries are vital to the livelihoods and sustainable future of coastal communities. Decades of intensive fisheries extraction, exacerbated by coastal degradation, have reduced many shellfish populations and most are overexploited. Thus, sustaining healthy shellfish resources will require new perspectives for rational shellfish management, which includes the implementation of resilient management systems and effective governance under conditions of change and uncertainty. Using long-term information on bio-socio-economic indicators, I address the impacts of the implementation of co-management and territorial user’s rights in these fisheries, and explore the linkages between humans and ecosystems in these social-ecological systems. Even though results varied among locations, the implementation of this type of management system in representative LA shellfisheries has: 1) stabilized landings at levels similar to early fishery phases; 2) increased shellfish abundances, individual sizes, CPUE and economic revenues per unit of effort; 3) reduced inter-annual variability in these indicators; and 4) increased abundance of non-target sympatric fauna. To ensure positive outcomes in the future, the effects of climate change will require attention: in some of the analyzed shellfisheries where co-management and area-based rights were implemented, massive mortalities decimated populations along their entire ranges, suggesting that the effects of climate change could undermine management measures. The recent creation of a South American Network for Shellfish Conservation and Restoration provides an important forum for raising awareness and transferring lessons about shellfish management and the effects of climate-driven changes in these stocks.
Is herbivory restored after plant reintroduction in tropical dry forests?
del Val, Ek; Y. Hernández, I. Baeza, C. Martínez-Garza
Centro de Investigaciones en Ecosistemas, UNAM, Mexico

Ecological restoration aims to reestablish ecosystem functions, however evaluation of restoration projects generally only takes into consideration whether plant cover is reestablished or whether diversity of certain groups is similar to reference sites. In order to go deeper into the understanding if ecosystem functions can be restored with afforestation in the tropical dry forest, we evaluated one important ecosystem function: herbivory, in restored and control sites. In Chamela, Jalisco we compared herbivory rates in two tropical trees (Apoplanesia paniculata and Heliocarpus pallidus) in a restored site vs a successional site, and found no differences in leaf area removed by herbivores (p>0.05). In Sierra de Huautla, Morelos we compared herbivory rates in two tropical trees (Heliocarpus appendiculatus and Ipomoea pauciflora) in enriched sites vs successional sites finding greater herbivory rates in enriched sites. In Chamela, regarding lepidopteran larvae on study plants, we found no differences in species richness and abundance per plant but species composition was different. In Sierra de Huautla, lepidopteran larvae richness was similar between sites but larvae abundance was higher at enriched sites, whereas species composition was different between sites. These results show that ecosystem recovery in tropical dry forests may be speeded up with afforestation.

Plant-herbivore networks: Understanding how are they reassembled after perturbation
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Network theory has mainly focused on mutualist interactions, however studies on antagonistic interactions (prey-predators and plant-herbivore) are beginning to use this approach to understand patterns and dynamics. In general interaction networks have been studied in pristine ecosystems and since most systems are somehow perturbed, there is a claim to understand how they change in disturbed sites and how they are reassembled in restored sites. We studied plant - herbivore networks along a secondary successional gradient and in a restored site in a tropical dry forest of Mexico. In order to construct the networks we sampled Lepidopteran larvae and their food trees in 12 plots of different abandonment time during 4 consecutive years in the Chamela Region, Jalisco. We found that trophic networks along the successional gradient show a nested pattern, and they get larger as succession proceeds (p<0.05). Lepidopteran species maintain their food preferences along the gradient. Specialization levels of Lepidopteran larvae also remain similar along the gradient (30%, p>0.05) but total species richness (plants and Lepidopterans) increases with succession (Lepidopterans: 40 species in abandoned grasslands and 100 species in mature forests, p<0.05; Plants: 38 species in abandoned grasslands and 78 species in mature forests, p<0.05). The restored site had intermediate levels of network size and species richness (Lepidopterans and plants), and specialization levels were similar. Understanding plant-herbivore networks can help to prioritize plant species that should be used in restoration experiences in order to promote ecosystem function recovery.

Efecto del pH en la germinación de Buchloe dactylolides y Cynodon dactylon en suelo contaminado con metales y metaloides
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Resumen Las presas de jares resultantes de la minería en México representan un gran problema ambiental de alto impacto por la contaminación de metales pesados y metaloides. La fitoremediación es una técnica innovadora en la remediación de sitios contaminados con metales y metaloides. El objetivo del presente estudio fue analizar la germinación de dos tipos de zacates (Buchloe dactylolides y Cynodon dactylon) en un suelo contaminado con metales y metaloides variando el pH del suelo. Estas especies son nativas de regiones semiáridas, tolerantes a la sequía y a temperaturas bajas, por ello constituyen una buena alternativa para climas áridos. El experimento consistió en observar la germinación de las dos diferentes especies de zacates en suelo con alto contenido de As, Cd, Pb y Zn, en un rango de pH en el suelo de 5 a 9. Se consideraron cuatro repeticiones por tipo de semilla y suelo (tratamiento). Los resultados fueron analizados empleando un modelo estadístico lineal generalizado con apareamiento desbalanceado utilizando dos factores (semilla y tratamiento). Se obtuvieron diferencias estadísticas entre los tratamientos y tipos de semillas. Se compararon las medias por Tukey y el coeficiente de variación del z. Buchloe dactylolides fue del 22,9 %, y en el z. Cynodon dactylon de 41,4 %, Concluyéndose que el zacate Buchloe dactylolides fue el de mejor germinación en los suelos analizados.
Low input methods of forest restoration and observations of native birds and flying foxes in savanna habitat in the Lake Ngardok Nature Reserve, Palau

Dendy, Julian
University of Hawaii, USA

Few studies have focused on forest restoration through patch expansion in the Pacific, and the use of native tree species in restoration has been a research need for decades in the region. The use of savanna habitat by Palau’s avifauna and flying foxes, which are thought to be the country’s primary seed dispersers, is unstudied. We assessed several low input restoration management techniques applied to small forest patches in savanna habitat, growth data for 5 native tree species planted around patches, and patch use trends of native birds and flying foxes in the Lake Ngardok Nature Reserve, Palau. We found that fertilizer applied to the interior of forest patches increased the growth rate of saplings along the perimeter (p<0.01), and increased four measures of patch phenology (p<0.001). Pruning of herbaceous vegetation around the patch perimeters resulted in higher seedling abundance and species diversity (p<0.001). The native tree outplantings grew faster than perimeter patch saplings (p<0.001), and two native tree species, *Pterocarpus indicus* and *Macaranga carolinensis*, were the fastest growers. Birds visited fertilized patches more than non-fertilized patches (p<0.05), and patch area was the strongest predictor of bird visitation. Three native bird species are likely to be the primary seed dispersers in these patches, the endemic Dusky White Eye and Palau Cicadabird, and the Micronesian Starling. These results should help inform future forest restoration and management decisions in the reserve, Palau, and possibly other locations across the Pacific.

The effects of agricultural intensification on restoration of invertebrate communities in adjacent forest fragments

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Land-use intensification is increasing worldwide as the need for resources grows due to the growing human population. The increased fertilizer inputs and animal stocking rates that are part of increasing the yield in a production system have negative impacts on surrounding native ecosystems. This has important implications for the restoration and conservation of small forest remnants in lowland New Zealand, the majority of which are on private land. These remnants represent the only legacy of former natural ecosystems in many lowland regions of New Zealand, because conservation has historically been based around large national parks, the majority of which are in mountainous regions. If New Zealand is to restore and conserve a more representative range of lowland native ecosystems, conservation on private land is needed. The aim of my research is to test the effects of agricultural intensification on restoration of forest remnants on farmland. Variation in leaf-litter invertebrate biodiversity and leaf-litter decomposition rates in 22 native forest remnants (11 fenced, 11 unfenced) on farmland in the Te Miro district (Waikato Region, New Zealand) was measured. These data will be used to quantify the relative benefits of using conservation management actions (i.e. livestock exclusion) for the restoration of native forest remnants on farmland subject to different degrees of land-use intensification. I hypothesize that land-use intensification will decrease invertebrate biodiversity and decomposition rates in adjacent forest remnants, whilst the relative benefit of conservation management actions on forest remnants will increase with increasing land-use intensification.

Integrated approach to the control of the invasive species, *Lithobates catesbeianus*

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The invasive species, *Lithobates catesbeianus*, causes a severe threat to native protected amphibians and ecosystems in Belgium. Populations reproduce, and are widespread in several parts of the country. In the valley of the Grote Nete approximately 400 ponds are infected over a distance of 30 km. Direct eradication and population control of these invasive populations have high priority but are difficult due to the shyness of these animals and the unattainability of their habitats. In an integrated approach, the symbiosis of catch-methods and SMRT (male-sterility) is considered as the best option in this case. Different catch-methods and traps were evaluated for adults and tadpoles. One trap has proven to be the most efficient. In addition, several attractants from different food-groups have been tested to enhance the catch efficiency in laboratory and field conditions. The results in laboratory gave a clear preference for liver and black pudding. Sterilization of the males can be obtained by chemical procedures. In this case Bisazir was injected into male adult bullfrogs at 50mg/kg. Comet assays on the sperm were carried out to evaluate the fragmentation of the DNA within the sperm of treated and control animals. Bisazir injected bullfrogs show a
significantly higher olive moment in the sperm, thus implying a more fragmented DNA. These findings can enhance the efficiency to control Lithobates catesbeianus in pond ecosystems in Europe and therefore safeguard native biodiversity.

**Restoring Wyoming big sagebrush following wildfire using locally-collected, nursery-raised stock: Contrasting methods and predicting survival**


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Nursery-raised stock can be used to introduce desired species to a disturbed landscape. Wyoming big sagebrush (Artemisia tridentata wyomingensis)-dominated shrub-steppe habitats of the western United States are threatened by land-use change and altered fire regimes associated with expansion of cheatgrass (Bromus tectorum) and increased ignition frequency. Frequent, large wildfires can extirpate A. tridentata over large areas because regeneration is constrained by a short-lived seed-bank and limited dispersal ability. Active management is required to restore A. tridentata to burned areas of conservation concern. We compared the survival of locally-collected container vs. bare-root out-plantings of A. tridentata and examined the effectiveness of hydrogel and mycorrhizal treatments in promoting establishment. Plant stress was assessed one year after planting to correlate with long-term survival. Container stock had relatively consistent survival rates (28-34% survival after three years), while bareroot stock showed variable rates (11-54% survival). Size of container stock did not affect survival. Hydrogel and mycorrhizal treatments did not confer advantage to survival of bare-root seedlings. The proportion of stressed seedlings in Year 1 was negatively correlated with survival from Year 1 to Year 3. In areas that did not burn in a subsequent wildfire, survival in Year 8 was similar to that in Year 3, indicating that initial establishment was the greatest barrier to survival. Land managers can use relationships between initial planting stress and longer-term survival to determine whether supplemental plantings will be needed to reach restoration goals.

**Restoring oak forests and woodlands using modern silvicultural analogs to historic cultural fire regimes**

Dey, Daniel C.

USDA Forest Service

For thousands of years, the frequency and intensity of fire in eastern North America has been intricately linked with humans and climate. Low intensity fires readily reduced the density of smaller woody stems (<15cm in diameter). More intense fires removed large diameter trees. In a land where rainfall and soils are capable of supporting tree growth everywhere, it was the fire regime at any one location that determined the composition and structure of vegetation, and, hence the distribution of forest, woodland, and savanna. Frequent low intensity fires favored hardwood species that are able to regenerate through vegetative sprouting such as the oaks, reduced fire-sensitive hardwood and conifer species, and created woodland structures. In drought years, severe fires determined the distribution of open woodlands and savannas on the landscape. Oak was promoted in savannas and woodlands because sufficient light reached the forest floor for growth of oak reproduction. Occasional longer fire-free periods allowed oaks to recruit into the overstory. Infrequent fire promoted forests with complex structures dominated by shade tolerant species that out-competed the more light demanding oaks. Today, the dominance of oak in eastern North America is due largely to a long history of fire acting in combination with other disturbances. But, oak regeneration failures are widely reported and succession to other species is common since fires have been suppressed over the past 50 years. Restoration of oak forests and woodlands is possible but requires innovative combinations of traditional silvicultural regeneration methods and practices, including prescribed burning.

**Jardineria SIGLO XXI: Interactuando con el medio con flora nativa**

Di Salvo, Nora Amanda

Vivero San Lorenzo, Argentina

Objetivos: Considerando el concepto de que las plantas son “auténticas máquinas naturales” para mejorar nuestra calidad de vida y ante el real cambio climático global, se hace imprescindible la planificación de espacios o sistemas verdes públicos “equilibrados”, mediante procesos de revaloración, restauración, revegetación, reforestación, rehabilitación, enriquecimiento, conservación y mantenimiento interactuando con el medio. Conocímos éstos a implementar mediante técnicas de jardinería siglo XXI. Métodos: Relación más equilibrada entre la jardinería y el entorno urbano y rural; intervenir lo mínimo posible en los procesos naturales y acompañarlos; planificación del
verde urbano y rural, con un uso más cuidadoso con los recursos naturales. Resultados: Desarrollando técnicas interdisciplinarias entre Ecología del Paisaje y Arquitectura del Paisaje, nos permiten atender las necesidades comunitarias en los espacios verdes públicos o privados, incorporando al diseño especies nativas, como así también preservar los bosques naturales; preservar y fomentar la biodiversidad; mantener la estructura y composición del suelo; conservar nuestros bosques nativos; corredores verdes; parques forestales; parques lineales; parches ecológicos; etc. Conclusión: Como propuesta paisajística a futuro, podríamos hacer una primera aproximación en cada zona geográfica, observando variables de: Regulación de humedad y temperatura; Reducción y control de erosión; Fijación de pendientes; Filtro acústico y reducción de viento; etc.

**Manejo del establecimiento de plántulas del arbusto invasor Ulex europaeus bajo doseles sembrados de Lupinus mirabilis, Lupinus bogotensis y Vicia beghalensis en Chisacá, Bogotá, Colombia**

**Díaz Espinosa, Adriana Marcela; O. Vargas**

Universidad Nacional de Colombia

Se realizó un experimento de control del establecimiento de plántulas de *Ulex europaeus* mediante la siembra de leguminosas de diferente forma de crecimiento (*Lupinus mirabilis, Lupinus bogotensis* y *Vicia beghalensis*). El experimento se realizó dentro del Parque ecológico de Montaña la Regadera (Bogotá, Colombia). Se utilizó un diseño en parcelas divididas (“split plot”), en los cuales se evaluó el establecimiento de plántulas de retamo bajo diferentes tratamientos con arbustos nativos y hierbas leguminosas y su efecto diferencial en el tiempo. La biomasa de plántulas de retamo (gorse), representada por el cociente entre la longitud y la biomasa de plántulas se vio afectada por los tratamientos que producían más sombra como *L. mirabilis* y la parcela mixta (F: 25.987 d.f 4 P<0.05). Por otro lado, la intensidad de la competencia aumentó con el tiempo (F: 9.90 d.f 3 p<0.05) y en los tratamientos con doseles de *L. mirabilis* y parcelas mixtas (F: 26.66 d.f 1 p <0.05), esta última triplicó la competencia entre los 100 y 160 días del experimento (IC: 0.80). También se encontró una relación lineal positiva entre el ancho del follaje de los doseles sembrados y el cociente LT/PST (r2 0.88); es decir, que bajo sombra una plántula tiene menos biomasa por unidad de longitud de tallo. Finalmente, es mayor la capacidad inhibitoria de las parcelas mixtas ya que tiene la arquitectura del follaje más compleja con un estrato bajo, medio y alto. Se recomienda luego del primer año reemplazar los doseles conformados por doseles de especies nativas perennes.

**Áreas piloto de restauración ecológica en los humedales de Juan Amarillo y la Vaca en Bogotá, Colombia**

**Díaz Espinosa, Adriana Marcela; Liliana Martínez, Orlando Vargas**

Universidad Nacional de Colombia

El humedal de Juan Amarillo y la Vaca son parte de los 13 Humedales con los que cuenta actualmente Bogotá, ambos tienen historias de uso muy diferentes; sin embargo en ellos se han adelantado acciones de mejoramiento ambiental que responden a las necesidades del sitio. Actualmente se están desarrollando experimentos de restauración para el control de especies invasoras que colonizan el borde entre la franja acuática y terrestre como *Pennisetum clandestinum* (Poaceae) y *Cucurbita ficifolia* (Cucurbitaceae). Debido a la carencia de especies nativas en el sitio, se hicieron recorridos por los 13 humedales y en la sabana de Bogotá. Se establecieron 6 experimentos, tres por zona, con casi 2000 individuos sembrados y 12 especies usadas. Para evaluar el establecimiento de las Cyperaceas y Juncaceas en la matriz de pasto o calabaza se utilizaron diferentes formas de manejo de la invasora, que van desde la remoción total de los rizomas, corte de césped o ramas y la sombra con plástico o membrana de fique (sólo para el pasto). Entre las variables muestreadas se encuentran la altura, cobertura y perímetro basal; así como observaciones del estado fenológico y porcentaje de hojas secas. Se destacan las especies *Cyperus rufus, Rynchospora sp* y *Eleocharis sp*, por ser las que presentan mayor crecimiento y potencial de competencia con el Kikuyo en las diferentes condiciones. También se han sembrado árboles que toleran inundación como *Salix humboldtiana* y *Alnus acuminata*, con un buen desempeño.

**From professional to artistic rationality in sustainability projects**

**Dieleman, Hans**

Universidad Autónoma de la Ciudad de México

Most sustainability and environmental projects follow a rather standard working scheme: formulate a vision, diagnose the problems, develop alternatives, seek consensus, take decisions and implement. This scheme is based on
what I like to call “professional rationality” as well as a science based model of handling problems: formulate the problem, analyze, plan and act. This scheme however limits out-of-the-box thinking and free floating creativity. Sustainability needs free floating creativity and completely new concepts, rather than solutions. That is one reason why many are trying to involve artists in sustainability. After all, art is a sphere of creativity and a domain of freedom and imagination. Yet, sustainability is not about artists or artworks. The issue is not to involve artists in sustainability. The challenge is how to make everyone an artist, very much in the Beuysian sense that we all are artists. But how? The paper presents an alternative working scheme based on “artistic rationality”, inspired by the work on organizational learning and reflective practice of Donald Schön and others. This scheme works in rather different ways. Some keywords are: 1) creating spaces of experimentation, 2) being intuitive and associative, 3) being iterative and reflective, 4) constantly leaving room for reinterpretation and adjustment, 5) using all life experiences and not only formal knowledge, 6) integrating form and content. To work like that invites to be open, creative and imaginative and is a good way to involve “art” in sustainability. The paper will explore some concrete examples to illustrate the argument.

Using indigenous science and western science to restore *Amphicarpaea bracteata* to the Standing Rock Lakota Reservation

**Different Cloud**, Linda

Sitting Bull College, USA

The loss of culturally important plant species is one of the great challenges facing Indigenous peoples today. Whether species are lost due to climate change or other human impacts, the consequences for Native communities is always palpable. Research has been undertaken to restore the vitally important food plant, *Amphicarpaea bracteata* back to the Standing Rock Lakota Reservation in North and South Dakota. *A. bracteata* (aka “mousebeans”) was not just important as a food source, but also provided a source of sacred ceremonial practices and recognition of the importance of reciprocity within ecosystems. Both Western and Native Scientific approaches will be used to determine the optimal growth and restoration conditions for this plant. A thorough review of existing literature as well as extensive interviews with Lakota elders will provide the ecological knowledge needed to revitalize the use of *Amphicarpaea bracteata* as a sacred food source. Data thus far suggests that there is a synergy between Native and Western Science and that both approaches will contribute to the overall success of *A. bracteata* restoration on Standing Rock.

Practice makes perfect in restoration in a biodiversity hotspot

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Kings Park and Botanic Garden, Australia

Hotspot restoration represents significant challenges both scientifically and technically with each of the 34 regions possessing unique ecosystems and high levels of endemism. Achieving ecological restoration in these regions through traditional institutional scientific approaches is unlikely to deliver the scope and scale of restoration needed now to address the accumulating ecosystem decline that is pervasive in the hotspots. This is particularly true of Australia’s only biodiversity hotspot, in southwest Western Australia. Though replete with outstanding academic and research institutions in southwest Western Australia, delivering effective restoration based on sound science will need a level of adaptive management approach where the feedback cycles of implementation, learning and innovation occur more seamlessly than at present. This is due in part to the scale and acceleration in habitat loss that is now occurring in this hotspot. An important part of the innovation cycle will need to involve practitioners at all levels where the science is entrusted to community members, learning is achieved through restoration practice and monitoring and reporting by the community is fed back into the scientific analysis. Achieving community engagement at a level that will empower the innovation cycles in restoration will need investment by scientists in community training and education and trust by scientists that well trained community members can deliver science into practice. Ultimately, the community will be the long-term stakeholders and indeed guardians of the restoration outcomes.

**Artropofauna como indicadora de restauración ecológica en áreas rehabilitadas del Complejo carbonífero del Cerrejón, La Guajira, Colombia**

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La minería a cielo abierto causa fuertes impactos a la biodiversidad debido a las capas de suelo que son removidas, por ello la industria minera desarrolla programas de rehabilitación los cuales requieren ser evaluados. Los artrópodos responden a cambios en la vegetación y suelo, siendo útiles como bioindicadores. Se comparó riqueza, abundancia y composición de artrópodos y grupos funcionales, en siete áreas con diferentes edades de rehabilitación (0–14 años) de una mina de carbón y un bosque nativo. Se realizaron tres muestreos, en cada sitio se instalaron 20 trampas de caída por 48 horas. Se colectó un total de 261 morfoespecies pertenecientes a 19 órdenes. La riqueza y la abundancia tienden a aumentar con el tiempo de rehabilitación, el área de 12 años presentó la mayor riqueza, el análisis de similitud agrupa las áreas de mayor tiempo de rehabilitación con el bosque. Importantes grupos tróficos como predadores y detritívoros son abundantes en todas las áreas, se destaca la rápida colonización de una especie de Grillidae. Haciendo uso de trampas pitfall, las hormigas son el grupo que mejor responde a los cambios en la cobertura vegetal, especies como Dorymyrmex biconis y Solenopsis geminata son altamente abundantes en estados iniciales. El programa de rehabilitación en la mina del Cerrejón propicia la colonización de artrópodos, se recomiendan acciones para facilitar la colonización entre sitios.

**Efectos a mediano plazo de deshierbes, método y densidad de siembra en una plantación de restauración sobre la recuperación ecosistémica**

*Douterlunghi, David; Nicolás de Jesús Méndez Guzmán*

El Colegio de La Frontera Sur, México

Plantaciones forestales son comúnmente usadas para restaurar áreas post-agricolas en el trópico húmedo. Prácticas como los deshierbes, densidad y métodos de siembra de los árboles influyen en su desempeño inicial pero poco se conoce sobre sus efectos a mediano plazo sobre las distintas trayectorias de restauración. Basado en el manejo tradicional Maya en México de *Ochroma pyramidale*, una pionera de rápido crecimiento, se restauró una milpa abandonada. Distintos niveles de deshierbe, densidad y método de siembra fueron evaluados en su capacidad de mejorar el establecimiento de Ochroma y el funcionamiento del ecosistema a mediano plazo. En las parcelas deshierbadas, Ochroma obtuvo mayores tasas de sobrevivencia y crecimiento, resultando 5 años después en una mayor acumulación de hojarasca y biomasa arbórea y penetración de luz en el sotobosque. No obstante, los deshierbes no marcaron diferencias en la biomasa de arvenses 5 años después de su aplicación. La regeneración natural arbórea fue más diversa y abundante tanto en parcelas no deshierbadas, como en aquellas donde se sembró Ochroma directamente de semillas en densidades más abiertas. Sorprendentemente, las parcelas control sin Ochroma reclutaron mayor abundancia y diversidad de juveniles que las parcelas donde se imita el manejo tradicional. Los manejos silvícolas que favorecen a corto plazo el establecimiento de Ochroma en plantaciones de restauración no necesariamente aceleran la recuperación ecosistémica a largo plazo.

**Pitfalls of translating Mayan local management & knowledge into broadly applicable restoration tools**

*Douterlunghi, David*

El Colegio de La Frontera Sur, México

Se reconoce los manejos y conocimientos ecológicos tradicionales o locales como una fuente de inspiración para programas de restauración. Sin embargo los manejos campesinos se forman según las particularidades ambientales y culturales locales y su adopción en zonas diferentes de su origen sigue siendo un reto. En la Selva Lacandona, el manejo ancestral de los barbechos con un pionero de rápido crecimiento *Ochroma pyramidale* permite una pronta recuperación de la fertilidad edáfica y suprime las arvenses heliófilas de competencia agresiva. Basado en este manejo, se diseñó diferentes experimentos factoriales en condiciones contrastantes: acualho o barbecho (a); área invadida por *Pteridium aquilinum* o “bracken” (b) y; potreros degradados (c). El último sitio representa una condición ajena al contexto natural del manejo tradicional. Los tratamientos incluyen tanto el manejo tradicional como modificaciones de este. Mientras que en el sitio a y b, *O. pyramidale* alcanzó altas tasas de sobrevivencia y crecimiento y eliminó las heliófilas dominantes, su desempeño en el sitio c fue mucho menor y otras especies demostraron tener más potencial para la restauración inicial. Los resultados experimentales ilustran las dificultades de extraer manejos locales de su contexto de origen. Experimentos factoriales in situ pueden detectar estas dificultades y evaluar las posibles modificaciones y adaptaciones para promoverlo en condiciones diversas. Enriquecer las estrategias tradicionales con mecanismos generadoras de ingresos puede aumentar su adopción en zonas sin nexos culturales con el manejo.
Suelos compactados y competencia herbácea como filtros ecológicos selectivos en plantaciones de restauración en una selva tropical

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El Colegio de La Frontera Sur, México

Plantaciones forestales catalizan la sucesión forestal en áreas degradadas. Su éxito depende de la selección de especies arbóreas y sus tasas de sobrevivencia y crecimiento inicial. No obstante el desempeño de plantaciones en sitios degradados demuestra poca constancia, impactando así la eficiencia de la restauración ecológica. Basados en manejos locales, se estableció una plantación experimental de restauración en la Selva Lacandona. Se evaluaron 7 tratamientos replicados en cuatro sitios degradados, se monitorea 2400 árboles perteneciendo a 6 especies establecidas por estaca o semilla en arreglos puras y mixtas. Después de un año de crecimiento, se cuantificó el impacto de dos barreras ecológicas a micro-escala: (i) la competencia con arvenses y (ii) los suelos compactados. La respuesta a los filtros ecológicos varía según especie. El árbol con mayor crecimiento en condiciones óptimas, Ochroma pyramidale, sufrió la mayor mortalidad y crecimiento retardado en suelos más compactados. Especies que naturalmente ocurren en pastizales abandonados (Guazuma ulmifolia y Trichospermum mexicanum) obtuvieron mejor desempeño en suelos duros. Sorprendentemente, la biomasa y altura de arvenses no demostró relaciones claras con el crecimiento y sobrevivencia de los árboles. Los resultados ilustran el uso de plantaciones mixtas para la restauración. Así también, la alta varianza en sobrevivencia y crecimiento de los árboles pone en duda la generalidad de recomendaciones provenientes de experimentos sin réplicas entre sitios.

An overview of social, economic and ecological considerations of restoration in Brazil

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Ecosystem restoration in Brazil is mostly associated with obligations in restoring legal reserves, permanent preservation, and compensation areas. Since researches have rather focused on the development of active restoration, this type of restoration prevails in Brazil, even though there are several techniques for both active and passive restoration. Additionally, local laws are restricted to account passive restoration for meeting legal obligations. Also, funding is supposed to be more successful for active restoration projects, mostly funded either by government programs or national and international non-governmental organizations. Mining companies have supported tree species planting projects since the 1980s. There are clear advances on restoration in Brazil, with four well developed research lines: total and enrichment planting (active), and natural regeneration and nucleation methods (passive restoration). We have more than 200 native tree species planted on thousands of hectares under restoration. Constant monitoring allows the improvement of techniques. Farmers who have legal reserve and permanent preservation areas restored may apply for certification. There is a great potential of turning payment for environmental services into an economical benefit. Social advances are represented by agroforestry, sustainable land-use system with a participatory approach mostly adopted in the poorest regions of Brazil. Recent networking efforts have been done to enhance ecological and socio-economical benefits from ecological restoration, as well as to influence public policies favoring ecological restoration.

Impact of weather conditions and landscape change on restoration success of inter-dunal wetlands in the Netherlands

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In European coastal dunes, dune slacks and salt marshes, habitat loss and absence of new habitat development are amongst the main causes of biodiversity loss. Thus restoration of these habitats often involve rewetting, top soil removal and moving of the stand vegetation. However, many such restoration projects often fail to achieve their desired goals. One hypothesis why these projects fail is due to weather fluctuation, which affects the hydrology and soil condition of the restored habitats. This paper investigates the effect of weather fluctuation i.e. an increase or a decrease of precipitation on dune slacks and their plant species. Our hypothesis is ‘weather fluctuation affects restoration outcomes significantly’ because the effect of dry or wet years could be drastic. We used long term monitoring data (20 years) to investigate the relationship between measured environmental variables such as pH, organic matter, different management regimes, groundwater levels and precipitation regimes by using a multivariate analysis (CANOCO). Our results suggest that the impact of meteorological condition on hydrology is significant, explaining 87 % of the variance in our hydrological model. Soil pH, soil organic matter and ground water level affect
dune slack species significantly. We conclude that dry period, even for one-season leads to a major shift in vegetation composition while wet periods are more preferable for dune slack species except during extreme flooding. We recommend that restoration projects should take into account the unpredictability of weather conditions and should aim to approaches that are more dynamic.

**Estimates and correlates of woody plant diversity and stored carbon in a tropical dry forest landscape in Yucatan, Mexico**

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Tropical dry forests (TDF) are one of the most extensive, threatened and least protected tropical ecosystems, despite their importance for conservation and the provision of ecosystem services. Understanding how TDF diversity and biomass varies across space and time is essential to restore, conserve and manage these ecosystems and their services. Our objective was to analyze the relationship of woody plant diversity and biomass with successional age, landscape structure and spatial dependence under different land-use scenarios in a TDF landscape in Yucatan. We calculated α diversity and above-ground biomass in 276 sampling plots, and obtained a land-cover map from a supervised classification using a SPOT5 satellite image. We used multiple regression and principal coordinates of neighbor matrices (PCNM) analysis to partition the variation in diversity and biomass among stand age, patch-type landscape structure (area, shape, contrast), and spatial dependence (PCNM vectors) components. We also explored the changes in diversity and biomass under different land-use scenarios. Stand age accounted for most of the variation in biomass, whereas landscape structure and spatial dependence explained as much variation in diversity as stand age. Our results suggest that forest disturbance and fragmentation decrease biomass, and that low levels of disturbance enhance diversity, whereas greater disturbance and fragmentation reduce diversity. Land-use changes could have a disproportionally greater effect on biomass than on diversity, but this effect depends on landscape configuration and suitability for different land uses. We discuss implications for the provision and estimation of ecosystem services in this TDF landscape.

**What if the restored ecosystem goes beyond the reference? The case of the Atlantic Forest, southeastern Brazil**

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Ecological restoration is relatively recent in the whole world and few projects are old enough to be comparable with reference natural ecosystems. We evaluated 26 riparian forest restoration projects in the Atlantic Forest (Brazil), aged between 4 and 53 years, and compared their structure and functioning with four pristine forests under the same environmental conditions. About twelve years after planting, all planted forests overcame the average stock of biomass of the native forests (178 Mg ha-1), becoming twice as much in about 28 years (344 Mg ha-1). The density of trees with DBH ≥ 10 cm is 30% higher in the restored ecosystems compared to the native forests. On the other hand, we found that seedling recruitment has been less than expected. Although density of small plants (DBH < 1 cm) is similar to the reference, the density of trees with 1 ≤ DBH < 10 cm is 34% (1225 ind ha-1) less than expected. We hypothesize that biomass in excess intensifies competition, especially for soil water, inhibiting recruitment. Based on the BEF theory applied to ecological restoration, adaptive management would be recommended aiming at reducing biomass and density of big trees, towards the expected on the basis of reference ecosystems. However, a question arises: if not managed, will these forests naturally suffer a high mortality of large trees and slowly recover the community structure of native forests? Searching for the answer, adaptive management has been experimented, but conclusive results will require long-term observations.

**Rainforestation: Enhancement of protected area management and community support through resource restoration - the case of Cross River National Park in south-eastern Nigeria**

Ebin, Clement; D. Out, G. Agba
African Ecological Restoration Foundation, Nigeria

The Nigerian rainforests are extensively degraded and their rich biodiversity lost. Consequently, only about 10% of the original forest is still intact. This remnant occurs in and around the Cross River National Park, in south-eastern Nigeria. Created in 1991, the 4,000km² park harbors rare and endangered fauna and flora species, with rich biodiversity and species endemism. However, one hundred and sixteen village communities are located near its
boundaries. These communities depend on forest resources for their livelihoods. The Park’s buffer areas have therefore been under extreme pressure, resulting in encroachment into the core of the Park. This project was designed to determine restoration measures that will provide ecological goods and services necessary for human needs, so as to stem the pressure on the Park’s resources. Forty square kilometers of the Park were sampled and thirty-nine communities surveyed. We evaluated four (ten-hectare sample) plots: two within the core of the Park and two in the buffer. Cluster sampling and direct observation techniques were used to evaluate the sites. Community needs were assessed through interviews. Findings showed serious deforestation and encroachment. Communities desire access to more forest resources. Trial restoration was also carried out, using tree species native to the area. However, more studies at larger locations are needed. We recommend an aggressive restoration program that will provide resources for man and wildlife within the Park and environs.

**The High Lonesome Ranch: Restoring carnivores, corridors, and connectivity on private lands**

_Eisenberg, Cristina; M. Soulé_

Oregon State University, USA

The High Lonesome Ranch (HLR) is a private working ranch located in north-central Colorado in the Spine of the Continent. It comprises 192,000 deeded and permitted acres surrounded by significant undeveloped public lands. It holds robust deer and elk herds as well as abundant cougars, black bears, and coyotes. Threatened and endangered species returning to this region include wolf and lynx. The HLR has adopted a contemporary conservation vision and land ethic model that builds on the legacy of eminent American conservationists Aldo Leopold and Michael Soulé to use best science to “rewild” ecosystems, by restoring carnivores, corridors, and connectivity. We are measuring the ecological effects of naturally repatriating keystone carnivores such as wolves, via trophic cascades science, and restoration of fundamental ecological forces, such as disturbance (e.g., fire), in creating a healthier, more resilient ecosystem. We are further investigating how carnivores and natural disturbance can be used to passively restore ecosystems by increasing biodiversity and energy flow, thereby working synergistically with active ecological restoration efforts. In this paper we identify key attributes for landscape-level ecological restoration and describe why private lands managed for conservation play a key role in restoring carnivores, corridors, and connectivity on a continental scale. We further discuss the usefulness of developing multi-dimensional, interdisciplinary science programs on private lands to help guide restoration objectives.

**Writing science: What scientists see but cannot say**

_Eisenberg, Cristina_

Oregon State University, USA

As scientists we are trained to be unbiased and objective, to think critically, and to avoid expressing qualitative opinions about our science. We are further taught that our role is to inform, rather than advise, and that even in the face of the most wicked ecological problems, we are to provide sober statements of scientific fact. However, facts alone and all the science in the world only provide part of the tools we need to help restore ecosystems as we face global climate disruption, increasing habitat fragmentation, unsustainable use of our natural resources, and attendant loss of biodiversity. In order to create positive change, one needs to touch people’s hearts and minds. Thus one of the roles of scientists is to sometimes say what we see but don’t often say—to express our sense of amazement and deep curiosity about the ecosystems and ecological relationships we study in a way that engages other scientists as well as a broader audience. Only by effectively communicating in a way that makes best science accessible, but also touches people emotionally, and only by conveying our own sense of humanness and humility, can we hope to yield understanding, render the answers that poets may dream but cannot write, and give wings to philosophical ideas about science, the humanities, and relationships in the natural world that will lead to sustainable solutions.

**The Who, What, and Where of Restoration as Part of REDD+ Implementation**

_Elias, Pipa_

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There is a great deal of momentum behind international cooperation to reduce emissions from tropical deforestation and degradation, conserve forest carbon stocks, sustainably manage forests, and increase forest carbon stocks (REDD+). As the policies and monetary incentives to practice REDD+ emerge, estimates of which practices should be implemented where would help move the political discussion forward. Using MODIS data, we evaluated the rate and extent of land abandonment in the Amazon arc of deforestation from 2002-2006. During this period the rate of deforestation was about 30 times higher than the rate of land abandonment, leaving scant and scattered parcels on
which restoration and carbon sequestration could occur. Total creation of secondary forests was 1,750 km². These low rates of land abandonment may be due to the increasing industrialization of deforesters and/or to changes in Brazilian forest policy. If agricultural productivity in the area increases, using land that has already been cleared, the potential for restoration may be lower, but there will be increased potential for forest conservation. Currently, while the scope of REDD+ appears to be set, it is unclear how implementation will occur. Analyses, including those on rates of land use change, the cost of forest restoration and carbon sequestration, and the opportunities for community involvement in forest management can be used to inform international REDD+ policy. Experts in forest restoration and conservation should share their experiences and findings with those government officials developing REDD+ policies.

Structural and functional indicators of restored ecosystems in Brazilian Atlantic Forest: Harmonizing ecosystems services and biodiversity conservation


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The strongest basis for ecological restoration during the last few decades in Brazil has been the community ecology, based on the premise that recovering the community structure will lead automatically to ecosystem functioning recovery. Otherwise, larger scale projects focused in ecosystems services usually fail to prove being effective in restoring Atlantic Forest biodiversity, one of World’s conservation hotspot. We tested some restoration models capable of playing both roles. Passive restoration (control) was compared to active restoration systems (direct sowing of fast growth species; agroforestry system; commercial mixed species plantation and a high diversity model) and to a reference neighbor native forest. After 10-13 years soil carbon stocks were higher in passive restoration systems, but the relative increase in soil organic matter (5 cm depth) was lower. Plantation systems were capable to maintain C/N ratios closer to the native forest and a higher carbon input by the litter layer. Active restoration systems produced 80-100% of native forest annual mean fine litter deposition, although fewer species contributed to the most part of it. The less complex active restoration systems were more productive, with high soil and phytomass carbon accumulation, but the more complex ones were closer to the native forest, considering phenological patterns, solar radiation regimes, natural regeneration species richness and density. All active systems were much more effective than passive restoration in recovering ecosystems processes as well as plant and animal biodiversity, with a high potential for providing environmental services.

Adaptive management can increase ecological, social and economic resilience from restored areas in Atlantic Forest, Brazil

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Although current ecosystem restoration approaches can yield good results in terms of biodiversity recovery, their high costs make them economically unattractive for large-scale application. While current silvicultural and ecological knowledge has yet to be effectively transmitted to policy-makers, economists, social workers and agricultural extensionists, there remain numerous technical barriers requiring further research. These include lack of experience in designing and managing mixed native species plantings for multiple environmental and socioeconomic benefits. In our region around 45-60% of small and medium land owners consider implantation costs limiting for forest restoration and they would be keen to adopt some alternative systems. To overcome these barriers it’s necessary to develop restoration techniques and management systems that simultaneously accelerate regeneration of species-rich native forest ecosystems and provide economically and socially valued forest products. Our results from 13-years monitoring of four alternative restoration systems that were designed within this approach have demonstrated that: a) even highly productive species-poor mixed plantation can provide habitat for wildlife and for the natural regeneration of allochthonous species; b) the more productive systems are attractive to land-owners because of lower implantation costs and higher direct incomes, but they need to be more carefully managed to permit structural complexity enhancement after around ten years of establishment, c) more complex restoration systems have a lower potential of short-term direct benefits, but they are potentially effective to provide long-term ecosystem services and multiple-use forest products; c) management techniques that take into account trade-offs between biodiversity conservation and forest yield need to be improved.
Seed farming in the arid zone: Overcoming difficulties in sourcing and germinating Triodia seeds for mine-site restoration

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Globally, the Pilbara region of Western Australia is one of the world’s largest iron ore provinces. Predicted land disturbance for iron ore extraction is currently estimated at around 30000 – 40000ha, with regulatory requirements to restore the landscape to resemble its pre-disturbed state after mine closure. Hummock grasses (Triodia spp.) in the Pilbara contribute the majority of plant abundance and cover in natural vegetation but are severely lacking or absent in historic restoration sites. Obtaining sufficient quantities of ‘germinable’ seed from the dominant grass species is a major focus for restoration practitioners. At a modest 6kg of seed per hectare, over the next five years (restoration target of 2000ha), the seed requirements for Triodia species is in excess of 12 tonnes for the area alone. Once collected, the establishment potential of each collection is further reduced because of poorly understood dormancy mechanisms restricting germination during periods of high rainfall. Therefore, research on Triodia species is currently focused on: (1) testing the effects of irrigation on the reproductive biology of natural populations to develop seed production areas, (2) whether different irrigation regimes change the reproductive output of plants through increased flower production and seed numbers, and (3) whether the different maternal environments during seed development and maturation alters seed size, level of dormancy, and germination traits. Development of seed farming areas and dormancy alleviating pre-treatments will ensure sufficient quantities of viable native seed are available for use in restoration and maximum germination occurs during periods conducive to plant establishment.

The influence of landscape restoration patterns on the provision of ecological services

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Many, if not most, ecological services depend on restoration being carried out on a landscape scale. To be effective, large-scale restoration needs to be carefully located. Biodiversity conservation requires a degree of connectivity between forest fragments, while watershed protection and soil conservation requires that restoration on steep sites and riverine areas are given preference over restoration in flatter parts of the landscape. However, strategic interventions such as these are difficult to implement. They require careful planning and may involve coordinating the activities of large numbers of stakeholders. We discuss these issues using case studies from northern Thailand and northern Australia.

Linking ground-based and remotely sensed data to the assessment of vegetation recovery

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When assessing restoration projects there is a widespread need to move beyond traditional approaches for vegetation monitoring. Confidence in rehabilitation actions is becoming increasingly stringent as governments and communities become more aware of the impacts that degraded landscapes have on environmental values. It is unlikely that standard transects and small plots can accurately measure vegetation recovery when the target scale is generally at a landscape scale. Most standard ecological monitoring has low spatial replication and may misinterpret overall condition of a site, due to the high variability in vegetation composition and condition observed at low sampling intensities. With recent advances and availability of sensors, unmanned aerial vehicles (UAV) and spatial analysis tools, landscapes can be assessed at higher resolution than ever before. These tools also provide the ability to monitor revegetation at high spatial and temporal resolution. We present recent research on the integration of remotely-sensed UAV imagery and ground-based assessments to demonstrate the value of this approach at landscape scales to monitoring restoration success.

El Carmen, a new generation transboundary model of habitat and wildlife restoration

Espinosa Treviño, Alejandro
CEMEX

El Carmen, a conservation area located in the Natural Protected Areas Maderas del Carmen and Ocampo in north Coahuila Mexico, which encompasses deserts, grasslands, forests, and other biodiversity rich ecosystems. The area is recognized as a biodiversity hotspot and as an important ecological corridor that spans an international border. Since
2000, CEMEX have been working in this area in collaboration with other private landowners to protect approximately 200,000 hectares along the border of Mexico and the United States. El Carmen uses scientific research and habitat and wildlife management practices to restore and protect this large scale landscape. The priority efforts include scientific baseline inventories of the ecosystems, habitat restoration and wildlife reintroductions. Depleted grasslands are being mechanically treated and reseeded as a part of the comprehensive management plan. After 10 years of habitat restoration work, 10,000 hectares of the land have been restored and are now sustaining viable populations of native wildlife. This habitat restoration has allowed the reintroduction of native large mammal species that were extirpated from the region primarily due to land degradation and loss of habitat. Three large mammals that have been reintroduced are the desert bighorn sheep (Ovis canadensis mexicana), elk (Cervus elaphus) and pronghorn antelope (Antilocapra americana) which in time will contribute to the ecological and socio-economic needs of this region.

Hongos micorrízicos arbusculares asociados con plantas dominantes en campos agrícolas abandonados en el Desierto Sonorense

Esqueda Valle, Martín Candelario; Citlalli Harris-Valle, Eduardo Furrazola, Aldo Gutiérrez, Alejandro E. Castellanos, Alfonso A. Gardea, Ricardo Berbara
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El estudio edáfico sobre la dinámica biológica ha demostrado que los microorganismos simbióticos como los hongos micorrízicos arbusculares (HMA) influyen de forma decisiva sobre la productividad primaria, la composición de las comunidades vegetales y forman parte de una estrategia alternativa para la restauración de la vegetación nativa en áreas ecológicamente perturbadas por la agricultura. El presente estudio se realizó en La Costa de Hermosillo, Sonora, México comprendida en el Desierto Sonorense, donde más de 80 mil ha están abandonadas por mal manejo. Se evaluó la diversidad de HMA y las características de micorrización en la época de sequía y precipitación, en plantas silvestres dominantes en campos agrícolas abandonados. Con base en la morfología de las esporas de HMA se determinaron 30 morfo especies, dos de las cuales fueron más abundantes en todos los campos muestreados. La diversidad de HMA varió en respuesta a los factores bióticos y abióticos, más aún presentó una es por ulación contrastante en función de la abundancia relativa de cada morfoespecie, cuando se comparó la estación seca y húmeda. Así mismo, la simbiosis fluctuó de acuerdo a las características edáficas, planta hospedera y clima. Durante la época de sequía, la variación en la interacción planta-HMA se relacionó con la salinidad del suelo. En la época de lluvias, la textura y la humedad del suelo fueron los componentes abióticos más relacionados con los cambios en las características simbióticas. Estos estudios básicos coadyuvarían en mejorar las prácticas agrícolas, la restauración de ecosistemas áridos degradados y las estrategias de conservación del ecosistema.

Cuantificación de glomalina en campos agrícolas abandonados y sitios naturales en el Desierto Sonorense

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Los hongos micorrízicos arbusculares son organismos clave del sistema suelo-planta, afectando la fertilidad, agregación y estabilidad suelo, así como la nutrición vegetal mediante la acción combinada de su micelio extrarradical y de una sustancia proteica hidrofóbica denominada glomalina. El objetivo del presente trabajo fue determinar la vegetación dominante y cuantificar bajo su dosel, la concentración de glomalina total (GT) y glomalina fácilmente extraible (GFE) en campos agrícolas abandonados con suelos salinos (3.4-4.3 dS m⁻¹) y no salinos (1.0-1.4 dS m⁻¹), así como en sitios naturales no perturbados de La Costa de Hermosillo, Sonora, México. El área de estudio está comprendida en el Desierto Sonorense. Los valores más altos para GFE se encontraron en los sitios naturales (0.41 mg g⁻¹), siendo significativamente mayor que las concentraciones determinadas en suelos agrícolas abandonados salinos y no salinos. Contrariamente en GT, los contenidos más elevados se observaron en campos agrícolas abandonados no salinos (7.8 mg g⁻¹), siendo mayor (P<0.01) que en campos salinos y sitios no perturbados. La alteración de las condiciones edáficas por el disturbio agrícola del paso de maquinaria, aplicación de agroquímicos, monocultivo, entre otros, pudieron afectar negativamente el crecimiento y la actividad de los hongos micorrízicos arbusculares, haciendo más lenta la producción y la descomposición de glomalina en los campos agrícolas abandonados. La finalidad de estos estudios básicos es generar estrategias para la restauración y conservación de los ambientes áridos impactados por la actividad antropogénica.
Post-fire land restoration in the arid western United States

Etra, Julie
Western Botanical Services Inc., USA

Open space in northern Nevada, including both public and private land, is subject to frequent intense fires. This phenomenon continues the cycle of invasive weed establishment and persistence, damages the soil ecosystem, and limits the re-establishment of sustainable native plant communities. In 2009 Washoe County (Department of Regional Parks and Open Space) received funding through the American Recovery & Reinvestment Act for restoration of non-federally owned properties within areas that had burned in seven fires that occurred in the county over a number of years. Through a competitive process Western Botanical Services Inc. (WBS) was selected and allowed to choose two of the seven fire areas for restoration design work. The Hawken and Peavine Fire areas were selected due to their size, complexity, and urgency for treatment. The Hawken Fire of 2007 devastated more than 2709 acres of land of which 760 acres are non-federal lands adjacent to forested lands. The Peavine Fire (AKA Verdi Complex) occurred in 2004 on 1079 acres of land, 919 of those acres being non-federal lands adjacent to forested lands. The WBS team developed the erosion control, restoration, and fuels management plans, specifications, and cost estimates for the two areas and is currently overseeing implementation. Innovative designs include establishment of ‘island’ ecosystems for the natural distribution of propagules and symbiotic microorganisms by wildlife, use of inoculants, and seed coating to enhance native plant establishment in stands of invasive and noxious weeds. WBS is also providing monitoring support and record drawings.

Los jardines botánicos como centros de restauración ecológica

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La riqueza de diversidad de Latinoamérica y del Caribe se halla amenazada por el manejo no sustentable de sus recursos con fuertes implicancias de degradación ambiental. Los jardines botánicos a lo largo de su historia han desempeñado un papel crucial en la documentación de la diversidad vegetal. Hoy, frente a cambios globales en el clima, la biodiversidad y en el uso de la tierra, los jardines deben asumir un fuerte protagonismo en la restauración, sobre la base de sus capacidades científicas y técnicas. Se presentan aquí ejemplos de proyectos de restauración ecológica realizados en los últimos años por jardines miembros de la Asociación Latinoamericana y del Caribe de Jardines Botánicos. Esta ONG comprometida con la investigación, difusión, educación y conservación de la diversidad vegetal impulsa la restauración ecológica como una estrategia que permite recuperar ecosistemas y contribuir a la conservación de la naturaleza. Se busca promover y alentar la conservación de especies raras, extintas o amenazadas en el medio natural mediante bancos de germoplasma y otras técnicas de propagación y conservación. Los proyectos ejemplifican cómo la restauración ecológica puede incrementar la colaboración con otros actores para alcanzar objetivos. Proyectos de restauración han fortalecido estrategias comunicacionales y de educación ambiental, a fin de alertar sobre la necesidad de cambiar actitudes hacia el medio natural, modificando modalidades de producción y consumo.

Social initiatives as driving forces to rehabilitate/preserve wetlands and natural remnants in Buenos Aires megacity, Argentina

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Rocha (1,100 ha) and Santa Catalina wetlands (700 ha) are the last two major natural remnants of Buenos Aires metropolitan area. These areas, located in the Matanza-Riachuelo watershed, are isolated and immersed within an urban matrix. Nevertheless, they still harbour high species diversity (850 plants, 190 birds, >400 fungi) and habitat heterogeneity (grasslands, riparian vegetation, wetlands). Besides, the sites also have cultural, educational, archaeological and paleontological values, and ecological services (hydrological regulation). During the last decade, high pressures from real estate and other economic stakeholders threatened the persistence of Santa Catalina and Rocha wetlands. The aim of this paper is to summarize the actions of social groups committed with environmental protection. During 2007 key actors from NGOs, local communities, and academic sectors encouraged other social groups to start formal and direct actions. They submitted proposals to regional authorities in order to designate both wetlands as legal protected areas. Other actions included consensus meetings, public communication programs, biological inventories, and surveys to determine restoration needs. Harvesting of herbaceous and woody plant seeds allowed establishment of a public nursery of native plants for restoration of Celtis tala forest and other degraded sites. Management plans were also developed, especially to eradicate exotic woody plants and rehabilitate areas for
education and recreation activities. Since 2008, wetlands conservation petition gained strong public support: more than 54,000 signatures were collected. Further, the ecological degradation was partially reverted thanks to political and legal actions (2009) and followed by significant advances in legislative procedures (2010-present). Designation of the official Natural Preserve status is forthcoming.

**The potential of forest floor transfer for the restoration of understory communities**

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University of Alberta, Canada

At a coal mine in Alberta, Canada, a “forest floor transfer” restoration project took place in which forest floor material was salvaged at two depths (15 and 40 cm) from a native aspen forest and immediately placed at the same depths on a restoration site. The objectives of this study were 1) to assess the donor site as a source for understory plants for restoration and 2) to determine how depth of salvage influences the initiation and composition of the plant community on the restoration site. Vegetation surveys were conducted at the donor site prior to salvage to assess species composition and the seed bank was characterized from forest floor samples. Plant composition was determined at the restoration site after the first growing season. Results indicate that the donor site was dominated by later successional species, while the species composition at the restoration site contained more ruderal and non-native species. Approximately 44% of the native species present at the donor site were not found at the restoration site. Species cover and overall richness was higher in the 15 cm treatment than in the 40 cm treatment, but the additional species were ruderal and non-native species. This result indicates that native understory species composition was not different between the two salvage depth treatments. The results of this research show that direct placement of forest floor is a feasible option to augment the establishment of an understory plant community on restoration.

**Efecto de la restauración sobre la composición de los hongos micorrízicos arbusculares en un área de bosque seco tropical en la Isla de Margarita, Venezuela**

**Fajardo, Laurie; Gisela Cuenca, Pauline Arrindell, Ramón Capote Zamira, Hasmy Héctor Linares**

Instituto Venezolano de Investigaciones Científicas

La afectación de los ecosistemas terrestres por efecto de las actividades antrópicas generalmente viene acompañada no solo de la pérdida de la cobertura vegetal, sino también de muchas de las propiedades físicoquímicas y biológicas claves de los suelos destacando la reducción del potencial de los simbiontes microbianos mutualistas, factores ecológicos importantes en el ciclo de nutrientes y en el sostenimiento de la vegetación en los ecosistemas naturales. Entre estos simbiontes destacan los hongos micorrízicos arbusculares (HMA), conocidos por sus múltiples beneficios sobre el crecimiento de las plantas. En diciembre de 2005, se realizó un ensayo de restauración de áreas de bosques secos afectadas por la extracción de arena a través de la siembra de especies arbóreas nativas sometidas a diferentes tratamientos. Cinco años después se evaluó el estado de las comunidades de HMA en aquellas parcelas donde la recuperación de la vegetación fue exitosa, para luego compararlo con aquél encontrado tanto en parcelas bajo sucesión natural con la misma edad de la restauración (5 años), como con las comunidades de HMA evaluadas en una zona relativamente poco perturbada. Los resultados obtenidos indican cambios en la composición y riqueza de HMA en las parcelas restauradas lo cual podría ser indicio de la recuperación de un atributo que podría reflejar la trayectoria de recuperación de este ecosistema altamente amenazado.

**Educación como clave para la restauración ecológica participativa (Páramo de Chiles, Nariño, Colombia)**

**Fajardo Gutiérrez, Francisco**

Universidad Nacional de Colombia

En el marco del Proyecto Páramo Andino ejecutado en Colombia por el Instituto Alexander von Humboldt, se realizó un programa de restauración ecológica en el Resguardo Indígena de Chiles, departamento de Nariño. La fase de diagnóstico en el 2008 permitió conocer los diferentes ecosistemas altoandinos de Chiles y su grado de conservación o deterioro, así como los actores sociales y especies vegetales claves para adelantar procesos de restauración. Sien embargo el hecho que más impulsó a la comunidad local a integrarse en las acciones de restauración fue el Curso Teórico Práctico de Restauración Ecológica que logró hacer una traducción exitosa de los conceptos de ecología de la restauración, de conservación de los ecosistemas y de técnicas y tecnologías para asistir a la recuperación natural de los ecosistemas disturbados. El curso de 6 días contó con la participación de 34 personas, los estudiantes que aprobaron el Curso recibieron una certificación de participación. A partir de este punto el proceso de restauración entró en una etapa de implementación de estrategias y técnicas puntuales que involucró 7 áreas piloto de
restauración, propagación de 37 especies nativas en un vivero local. El interés que el Curso propició dentro de la comunidad ayuda a generar conciencia sobre la relación del hombre con su entorno natural y dará continuidad a los esfuerzos iniciales.

**Monitoring for recovery of a watershed in the intermountain United States and its economic impacts**

Farag, Aida; D. D. Harper, K. E. Skrabis

US Geological Survey

Abandoned mine and stream channel reclamation and remediation projects were conducted in several tributaries of the Boulder River, Montana, USA from 1997 to 2005. Most restoration efforts in the watershed rely on natural attenuation of aquatic habitat. The State of Montana, USA maintains a significant tourism economy and is defined by blue ribbon fisheries, however the biota within the Boulder River has been significantly impacted by historic mining activity. Personal property values may increase as recovery of the watershed is observed. We first assessed the effects of trace metals on aquatic health in this watershed in 1997, prior to remediation activities. Therefore, an accurate assessment of the success of remediation efforts and the reliance on natural attenuation is important for the economic future of this watershed, and as an example for abandoned and active mine areas around the world. In years following the initial assessment (2003 and 2009), we investigated three types of parameters to monitor potential recovery of the watershed: 1.) Concentrations of As, Cd, Cu, Pb, and Zn in water, biofilm and macroinvertebrates, 2.) Benthic macroinvertebrate assemblage and aquatic habitat quality 3.) In situ survival experiments with juvenile cutthroat trout. When compared to previous years, remediation and natural attenuation appear to have a positive effect on trace metal concentrations, invertebrate assemblage and in situ survival, but the parameters are still affected when compared to reference sites. Therefore, aquatic health and economic factors could benefit from additional restoration activities in the watershed.

**Marsh Arabs and the environmental changes in southern Iraq marshes**

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Basrah University, Iraq

For 5,000 years, the Ma’dan or Marsh Arabs lived in the marshes of southern Iraq. The destruction of the marshes – and the people who lived in them – accelerated rapidly after the first Gulf War. A population that had numbered over 250,000 in 1990 was reduced to approximately 20,000 in less than 10 years. This paper assesses how the years of war, sanctions, and environmental changes have adversely impacted their traditional way of life; the displacement of these people has also had a negative impact on their environment. Accounts of three different marsh villages are discussed: Al-Malha, Al-Douwa and Al-Salheia. This study demonstrates that proximity of the first two villages to oil field installations resulting in oil companies preventing fishing and herding of water buffalo. The group that settled in Al-Salheia area is facing increased water salinity of the Shatt Al-Arab waterway. Villagers have caused widespread soil erosion and water pollution through inadequate and unsustainable agricultural practices. Faced with challenges particular to their conditions, Marsh Arabs are suffering. Currently they lack basic services including: access to clean water, sanitation, accessible roads, schools, employment and health clinics. There has been a distinctive loss of cultural traditions, the results of which are comparable to the broader effects of ecological damage. This unique area of wetlands has been contaminated and destroyed. What has occurred and continues to happen has had a much wider series of implications on Iraq’s environment and the consequent social issues.

**Restoration versus restitution: Are there some ecosystems that we can’t directly fix?**

Feagin, Rusty

Texas A&M University, USA

The Deepwater Horizon oil spill altered many ecosystems in the Gulf of Mexico. While scientists have recorded the physical presence of oil and dispersants in many ecosystems, we do not know exactly how ecosystem functioning has been impaired. Moreover, quantifying the cost of the damage and deciding what needs to be restored is a large challenge. The restoration of the Gulf likely will be a strategic endeavor that does not directly fix the impacted ecosystems. Rather, restoration will likely: (1) create new, comparative ecosystems through conservation or construction, and (2) act as a financial instrument for the exchange of non-market value (Ecosystem Service Values), allowing private companies to compensate the public for very-difficult-to-ascertain damage costs. In this context, new restoration projects may be paid for, in locations that were not directly impacted by oil. Standard restoration techniques can then be employed for beaches, dunes, wetlands, fisheries, and the deep ocean. These restoration sites
will have to be strategically planned, and placed at spatial locations that maximize their benefits, such as for fisheries, storm protection, carbon sequestration, water purification, or habitat value. An important question is whether the ‘trade-in’ value of this privately-funded restoration should be based on the construction cost of the projects, or the return benefit of ecosystem service functioning to the Gulf. While there are some ecosystem functions that cannot be directly assessed and restored relative to their pre-oiled state, restoration may become the common currency through which restitution is paid.

**Sustainable ranching inspires tropical forest restoration strategies**

**Ferguson, Bruce G.; Stewart A. W. Diemont**

El Colegio de la Frontera Sur, Mexico

Tropical cattle ranching is intimately linked with deforestation and land degradation. However, members of a holistic ranching collective in dry forest region of Chiapas utilize practices that actually favor soil fertility, tree establishment, biodiversity and ecosystem services. Such practices include rotational grazing, selective manual weeding, diversification of forage and ranch products, landscape-level planning and maintenance of forest reserves. These holistic ranchers do not burn their pastures and, compared to their conventional neighbors, they apply less agrochemicals and have thicker ground cover as well as soils with deeper organic horizons and more biological activity. At the same time, holistic management favors ranch economies by reducing the need for purchased feed, increasing milk productivity and lowering cow and calf mortality. These and other small-medium scale ranchers manage a set of multiple-use, dry-forest trees that are dispersed by their cattle, including *Guazuma ulmifolia* and the legumes *Enterolobium cyclocarpum*, *Pithecellobium dulce* and *Acacia pennatula*. These trees offer high-value fodder, as well as other products and services such as firewood and construction material. Many ranchers promote growth of these trees from cattle dung, manage their density, and prune them to facilitate browsing. The autochthonous silvopastoral systems that result, together with holistic management practices, could serve as steps toward ecological restoration in grazing lands. Intriguing parallels emerge between sustainable ranching and the traditional management of the agriculture-forest cycle by lowland Maya, also discussed in this session.

**Maya fallow management: Applications to restoration design**

**Ferguson, Bruce G.; Stewart A. W. Diemont**

El Colegio de la Frontera Sur, Mexico

Traditional lowland Maya milpas are often simplified in the literature as shifting cultivation systems. These systems are often in fact complex human-forest systems that undergo cycles of forest clearing, numerous cropping stages, including forest, and meticulous management of fallow. Key management elements include careful burns, polyculture, long-cycle rotation, manipulation of tree species composition, landscape-level management of a mosaic of fields and forest reserves, and minimal use of purchased inputs. Milperos influence the composition of the tree fallow by limiting seed arrival and by selective weeding favoring species that are useful directly and/or favor forest regeneration. We interviewed Maya farmers in several communities in Southern Mexico and Belize to catalog the species they prefer for accelerating succession. Across five different Mayan ethnics groups 30 species were recognized for forest restoration properties. We then performed observations and experiments to understand the successional role these species play. One such species, *Sapium lateriflorum*, appears to act as a phosphorous pump, augmenting concentrations of this nutrient beneath its canopy. Another, *Ochroma pyramidale*, creates thick mulch that resists decomposition, reducing concentrations of saprophytic nematodes in the soil. In this way, *Ochroma* likely maintains nutrients in the system that would otherwise leach from exposed soils. *Belotiamexicana* appears to decrease the carbon/nitrogen ratio of soil organic matter. By understanding the mechanisms underlying traditional management succession, we propose that restoration scientists can develop strategies for encouraging forest establishment where regeneration is arrested, while also providing considerable provisioning ecosystem services (raw material and food) in economically poor areas.

**Developing a system of reference for ecological evaluation in the frame of landscape and restoration planning processes**

**Fernandes, João Paulo; Nuno Guimara, Sílvia Benedict**

University of Évora, Portugal

Any evaluation process consists of qualitative and quantitative comparison procedures between the evaluation object and a similar object or system of reference. These must have a stable character and be described by the same characterization variables as the evaluation object. The definition of such a reference object in the frame of planning
or restoration processes gives rise to the problem of the process validity and reproducibility. These problems derive from the difficulty in identifying a moment or a quality of landscape organization and functionality as well as the potential, values and susceptibilities that a planning process must attend to or the nature and targets of any feasible restoration process. Such a reference system must, therefore, derive from the ecological factors that determine the natural occurrence of vegetation and allow the identification of distinct vegetation units expressing those factors and the associated processes. It is in this context that the concept of Reference Vegetation was developed as consisting in: “The vegetation that should occur in a given site in the present soil and climatic conditions when there would be no disturbance factors”. This concept gives us an object of reference that corresponds to the effective, present ecological factors and processes existing in a landscape. Its application to EIA, Planning and restoration processes is illustrated and discussed as well as its validation through the comparison with classical objects like the Potential Natural Vegetation. The effectiveness and limitations of the concept are discussed in different planning, conservation and restoration contexts.

**Conservation strategies for island - the "Park Island" of Pico (Azores)**

**Fernandes, João Paulo; Artur Gil**

University of Évora, Portugal

Nature conservation in an island context presents problems due mainly to isolation from colonization sources, danger of invasion and the identification of conservation values in the context of a complex mosaic of land use (and its historical evolution) and remaining natural and semi natural biotopes. The process of conservation values identification and characterization implies particular attention to the definition of the conditions allowing minimal viable populations and genetic diversity and the identification of the conditions that allow the existence, preservation and progress of those species, ecosystems and ecological systems. Therefore, the process of conservation planning and management in this context must go beyond classical paradigms of land use constraints in target areas and build a global approach to the ecological improvement of the entire island with particular attention to the land use systems and their interaction with the island natural values. Such an approach is being implemented in the Pico Island (Azores) through the concept of "Island Park" where the viability of the classical preserved areas model is being compared with the integrated approach aimed at potentiating the ecological value of every parcel of the island, maximizing the contribution of economical land uses to conservation targets and identifying areas whose characteristics are more suited for restoration processes ensuring the necessary conditions for the viability of the ecological systems to be protected. Different instruments are being tested like ecological networks based on present values and the identification and restoration of gaps using new tools like the concept of "Reference Vegetation".

**Building a Database of plants for restoration processes in the mediterranean context - criteria and current research**

**Fernandes, João Paulo; Carlos Souto Cruz, Henrique Pires**

University of Évora, Portugal

The processes of ecological restoration and, in general, all the bioengineering interventions in the Mediterranean context are of particular complexity due to the natural constraints to plant installation and development. It is therefore critical to identify the ecological and biotechnical characteristics of the available species, their biogeography habits. Although much research has been done on these subjects, it is not systematic and specifically aimed to the restoration or bioengineering demands. In order to fill this gap, the University of Évora is starting a project of an open database where this information is gathered and made available to the different uses, incorporating standardized methodologies to assess particular important eco-technical characteristics of the plants. The present template includes following sets of data for each species: • Ecological characteristics o Biogeography o Phytosociology o Habitat o Bioindicator value o Ecological strategies (propagation, CSR classification) • Morphometric characteristics o Dendrology o Root system o Root parameterization o Synthetic parameters (root architecture, stability and resistance) • Technical characteristics o Physical properties o Biochemical properties o Biotechnical function. Data is already been gathered from Portugal, Spain and Italy and expert criteria for the selection of site-specific species are being developed on the basis of the results of research on ecological restoration and bioengineering in different contexts, habitats and biogeographical areas. This is an ongoing project capable of including other bioregions and datasets, particularly in terms of technical applicability in restoration and renaturalization projects.
Restoring regulation: An assessment of California's regulatory process for ecological restoration projects

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My research questions whether projects that seek to improve environmental quality, such as ecological restoration, should follow the same regulatory process that was designed to minimize and disclose the impacts of environmentally damaging projects. Should an alternative environmental review process be created for certain types of projects? Could the existing process be revised to more effectively reduce the short-term impacts of projects seeking long-term environmental improvements while encouraging their implementation? To answer these questions, I examined the history of environmental policy and ecological restoration in the United States. I also conducted interviews with staff from non-profit organizations, public agencies, environmental consulting firms, and regulatory agencies. Finally I gathered case studies on the interaction between restoration projects and the regulatory process. In interviews, staff members have almost universally stated that the environmental review process benefits restoration projects by forcing restoration designers to consider a broader range of environmental impacts than may have been considered without review. However, many interviewees have suggested innovative improvements to the review process, such as incorporating peer review to improve restoration designs, designating particular staff as restoration specialists at regulatory agencies, improving environmental regulations’ compatibility with an adaptive management approach to restoration and increasing the use of digital information sharing to improve educational and outreach potential. During interviews, participants have described momentum within regulatory agencies to improve the environmental review process. Through my research I hope to summarize practical opportunities for improvement at both the policy and bureaucracy level.

Prospección, caracterización y selección de gramíneas forrajeras altoandinas como potenciales productoras de los páramos ecuatorianos

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La presente investigación se realizó en las reservas protegidas del Ecuador en la zona interandina, la misma tuvo una duración de siete años Los sitios investigados están caracterizados en un reino nevado; dominio de tundra y provincia de tundra húmeda nubosa característico del páramo. El pH del suelo volcánico, con características arenoso y arcilloso, varía comúnmente entre 5.0 y 8.5. Las especies identificadas en los páramos ecuatorianos fueron 169 plantas con importancia forrajera. 90 Gramíneas, 14 Leguminosas, 28 Compuestas y 37 (Equitaceas, Oxalidaceas, Liliaceas, Scrophulariaceas, Rosaceas, Ciperaceas, Plantaginaceas, Arbutivas, Orchideaceas, Ranunculaceas, y Gentianaceas). Los índices de biodiversidad indican una uniformidad media/alta de las especies. Los componentes acumulados 77.7 y 87.6% de variabilidad, destacándose las variables de mayor peso: cobertura basal, aérea, densidad, frecuencia y composición botánica; en el segundo la altura de la planta, siendo las que caracterizan gramíneas naturales y naturalizadas. La sucesión vegetal 18 especies mostraron buen comportamiento al ser detectadas al menos en un sitio; siendo mayor persistencia y adaptación. Respecto a la producción de forraje resultaron como mejores Euchlaena mexicana con 25.9 y 6.7 t/ha/corte y Arrhenatherumelatius con 24.4 y 6.9 t/ha/corte de forraje verde y seco, respectivamente, además de Arrhenatherum pratense (23.0 y 6.1 t/ha/corte) y Stipaplumeris (21.9 y 6.8 t/ha/corte).

Deserving our dreams: An ecological and evolutionary dialectic in the service of restoring biodiversity hotspots

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Without doubt, biodiversity hotspots around the globe will continue to be degraded, but at varying rates and through different processes. Deforestation, agricultural conversion, livestock production, and human population growth are among the most formidable forces of ecological change that will require ecologically and evolutionarily informed responses to restore hotspot biodiversity. Foremost, however, is the need to understand biodiversity hotspots not solely as present-day communities defined by ecological functions, but also as evolutionary assemblages shaped in part by phylogenetic processes and landscape-scale climatological or geological characteristics. Identifying individual traits in species, communities, and ecosystems critical to successful biodiversity hotspot restoration requires both an understanding of ‘deep time’ evolutionary traits such as soil type restriction or fire response, and
present day ecological ones such as yearly seed set or herbivore response. Ultimately, we will have to widen our embrace of current scientific and artistic thinking to deserve our dream of biodiversity hotspot conservation.

**Breaking the silence: Finding hope in Mesopotamia**

Fleming, Tova; Michelle Stevens  
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Hima Mesopotamia: Water & Peace in the Middle East (HM) propose to use storying to describe the relationship between culture and ecosystems, to validate the reality of environmental refugees, and to powerfully inform the international community of environmental and social degradation. In 2009, scientists from the Basrah Marine Science Center, University of Iraq, asked Dr. Michelle Stevens for help organizing a conference outside of Iraq to inform the international community on the ecological crisis in Iraq. The request and subsequent organization of two symposia for the World Congress for Middle Eastern Studies (WOCMES), Barcelona, Spain, 2010, allowed for a roundtable discussion following the panel discussion, and there we asked participants working on biodiversity of the Middle East how HM and the international community can help the people of southern Iraq. They recommended telling the story of the reciprocal relationship between the Marsh Arab culture and nature in the Mesopotamian Marshes. Additionally, communication among grassroots organizations and scientists on the Tigris Euphrates watershed from Turkey, Syria, Iraq, Iran, and Kuwait, until now has been virtually non-existent. Communication and the sharing of stories both regionally and internationally are vitally important to creating equitable water rights allocation and eco cultural restoration. This talk will detail how water can be used as a way to facilitate international cooperation and help heal cultural strife in this ecologically and culturally rich region through reconnecting story to cultural and ecological restoration.

**Fenología reproductiva de especies arbóreas promisorias para procesos de restauración ecológica en algunas zonas de Venezuela**

Flores, Saúl; D. Albert, D. Torres, E. Trejo, F. F. Herrera  
Instituto Venezolano de Investigaciones Científicas

La alteración antrópica que han sufrido las comunidades vegetales por efecto de la deforestación y el fuego ha traído graves consecuencias, modificando las condiciones del suelo, su fertilidad y biodiversidad. Una herramienta fundamental para lograr revertir estos procesos es la restauración con especies nativas, que tengan el potencial de crecer en zonas alteradas. Para este estudio se realizó un análisis de la literatura y de muestras depositadas en el Jardín Botánico de Caracas, que permitió hacer una selección inicial de 140 especies (56 familias). Con el objeto de seleccionar las plantas más promisorias, se realizó un segundo corte, obteniendo 17 especies promisorias. De éstas, observamos que 52% presentan el mayor porcentaje de ocurrencia de flores en la estación seca y 47% en la estación lluviosa; en cuanto a la fenofase de frutos 65% en la estación seca y 29 % en la estación lluviosa, indicando que la mayoría de las especies estudiadas presentan periodos de fructificación en la estación seca, siendo la estación propicia para la colectas de semillas. La especies presentaron una amplia distribución altitudinal, de 0 a 2000 msnm. Los resultados indican que las especies seleccionadas presentan una amplia distribución vertical, y son susceptibles a encontrarse en variadas condiciones climáticas, aspecto relevante para la restauración en el trópico.

**Restauración del ciclo de nutrientes en áreas secas degradadas por sobrepastoreo mediante plantaciones de Nim (Azadirachta indica)**

Flórez Flórez, Claudia Patricia; Juan Diego León Peláez, Nelson Walter Osorio Vega  
Universidad Nacional de Colombia

Se evaluó el potencial de plantaciones de Nim para restaurar suelos degradados por sobrepastoreo en zonas secas, vía reactivación del ciclo biogequímico (CB). Los aportes anuales de materia orgánica como hojarasca fina (HF) representaron 558,54 kg/ha, siendo 33% hojas de Nim. Los mayores retornos potenciales anuales de nutrientes por hojarasca foliar fueron de Ca (4,6 kg/ha) y N (2,4 kg/ha), y los menores de P (0,06 kg/ha). El 68% del material foliar depositado en litter-bags desapareció tras un año del experimento. La mayor liberación de nutrientes fue de K (100%) y la menor de N (40%). A partir de la constante de descomposición anual (k=1,58) y de la caída de hojarasca foliar de Nim, los retornos efectivos de materia orgánica y carbono al suelo representarían 146 y 36 kg/ha/año. El P fue el nutriente más limitante, con baja disponibilidad edáfica, altos valores N/P en hojarasca foliar (39,2) y bajos valores P/N en hojas maduras (0,02), reflejando alta eficiencia en su uso según el Índice de Vitousek (IEV=3050) y la reabsorción foliar (34,5%). Estas plantaciones, aunque juveniles, han reactivado el CB, modificando positivamente
Has the soil seed bank the capacity to restore high biodiversity areas? Some case studies from New Caledonian ultramafic environment

Fogliani, Bruno; Laurent L’Huillier

University of New Caledonia

New Caledonia is a hotspot of biodiversity facing a double challenge, accompany a sustained economic development together to maintain remarkable environments. Among them, ultramafic rocks environments arises acutely, their flora being the richest and most original of the country. Since the awareness of the importance to protect and restore them, major efforts in research, development and application of methods have been made. The use of native species has been developed and efforts increased to collect and store seeds and also to understand the germination processes (dormancies, pre-treatments), mostly for producing seedlings in nurseries as well as for hydroseeding processes. The use of topsoil, both to improve the quality of the substrate and to provide a soil seed bank is more recent. Studies engaged by our teams revealed that the seed bank quality of topsoil is variable depending on the surrounding vegetation and on the depth of collection. However, germination led to a poorest species biodiversity coming essentially from hard seed with physical and/or physiological dormancies, with a predominance of Cyperaceae. These observations were confirmed using buried seeds at different depths in comparison with storage laboratory conditions and with effects of ageing in order to determine their capacities to survive in hard natural conditions. Finally, practically, it seems that a rational combination of using top soil and hydroseeding, with enrichment by dispersing seeds from surrounding vegetation, may permit the restoration of the highest biodiversity on a large scale. Thus, the establishment of a diversified seed bank appears essential.

Seed sourcing for restoration: Genetic implications of small populations

Foley, Michalie; Siegy Krauss

University of Western Australia/ Kings Park and Botanic Garden

Current restoration practice generally advocates collection of seed from within local genetic provenance. This stems from negative outcomes associated with introducing non-local seed, including maladaptation and outbreeding depression, which may result in reduced fitness and population decline. With increasing habitat fragmentation, especially in urban environments, small local populations may be genetically isolated by barriers that inhibit gene flow. Isolation can lead populations to suffer from elevated inbreeding, inbreeding depression and genetic erosion. Seed quality of these isolated populations may be compromised and reduce restoration success. To explore this issue, I assessed gene flow and seed quality in small and large populations of a common bird-pollinated species Banksia ericifolia (Proteaceae) within the Perth metropolitan area of Western Australia. Assessments of paternity on seed have allowed me to determine the pattern of pollen flow within small populations and large populations. This assessment quantifies the relative proportion of pollen that comes from outside the population and contributes to gene flow. In conjunction with this genetic assessment, I have found a higher incidence of aborted seed in small populations, suggesting inbreeding depression. An evaluation of the quality of seed has found that while there was no difference in germination, seedlings from small populations may not respond as well to stress as those from large populations. These studies inform restoration seed sourcing decisions and provide an indication as to whether the use of local seed from small local provenance populations is an effective tool in restoration.

The archaeology of traditional Maya farming

Ford, Anabel

Exploring Solutions Past/University of California, USA

Traditional Maya farming, land use, and forest knowledge provide a basis for interpreting ancient patterns and an appreciation of the time depth of these practices. Data on settlement patterns of the Late Classic Period Maya reflect a continuum of past land use. The densely settled areas of major and minor centers would have been intensive infield home gardens, to the extensive outfield milpa-forest gardens and the unoccupied extractive areas. By exploring solutions past, a geographic predictive model of Maya settlement reveals the efficacy of the milpa – forest garden cycle as a model to explain the ancient patterns and a basis on strategies to restore the Maya forest garden for the future.
**Developing the ecological restoration industry through innovation, communication and recognition to ensure it is part of a sustainable business model**

**Ford, Jen**  
Gold Coast City Council, Australia

In the last 5 years, ecological restoration on the Gold Coast has evolved significantly and is in the process of becoming part of core government business. The growth and up skilling of this industry has been vital so that we might achieve the restoration of an expanding estate that is more than 13000 hectares of fragmented land. The improvement of restoration industry standards has played a significant role in our department being able to grow from 2 permanent positions to 16 (and still growing), the budget to more than $2 million dollars a year and the expansion of the local industry, as we have been able to demonstrate an economically efficient approach to restoration. We have achieved greater efficiencies through delivering on-ground training, supporting learning institutions, by being more strategic in our planning and implementation of works, and by the innovation of many new systems. These innovations coupled with how we record restoration works has allowed us to make significant ground on ensuring dollars are spent effectively and that resources are also available for maintenance as we know better the true cost of restoration across a wide range of vegetation types and disturbance levels. Diversifying our income through programs such as ecological and carbon offsetting is another way we are ensuring our continued growth and consolidation into the future. The recognition of restoration is increasing on many levels and the systems we use to communicate the achievements is also assisting restoration is further being incorporated into core council business.

**Abandoned but not uninhabited: Urban vacancy as restoration strategy**

**Foster, Jennifer**  
York University, Canada

This presentation investigates possibilities for “unplanned” ecological restoration of former urban industrial space. Considering the political, cultural and biophysical dimensions of remnant industrial infrastructure, this presentation approaches restoration as habitat creation, as a complex of processes that occur regardless of human intent or design. The concept of “vague terrain” offers interesting possibilities for thinking about the ecological and social prospects of abandoned and spontaneously used space of murky status. Largely unmaintained, without overt human planning, upkeep or conservation intent, these spaces are vague both in spatial and temporal terms. No longer part of current civic preoccupations, these indeterminate zones often offer unique ecological opportunities and fulfill important social functions that are otherwise unavailable in urban settings. The case of the Petit Ceinture, a decommissioned railway in Paris, France, offers a compelling illustration of the possibilities of vacancy and vague terrain. Disused for almost two decades, the rail circuit now furnishes the city with a network of rich ecosystems and habitat connections through Paris and further afield.

**Soil fauna development and soil formation in reclaimed and unclaimed post mining sites**

**Frouz, Jan**  
Institute of Soil Biology BC ASCR, Czech Republic

Soil formation, in unclaimed and reclaimed post mining sites in alkaline tertiary clay spoil heaps in northwest was studied. Two chronosequences of sites (1-41 years old), alder plantations and unclaimed, and 30 year old reclaimed sites with plantations of various species were studied. Tree canopy closed in 15 year-old plantations. Unreclaimed sites, were covered by willow (Salix caprea) shrubs 15 years after heaping and young birch and poplar (Betulapendula and Populustremula) forest appeared 30 years after heaping. In unreclaimed sites macrofaunaabundances were low and appear in higher densities only in old sites, testacea amoebae and oribatid mites, densities in these sites were high, similar as in natural forests. Microbial respiration was similar to reclaimed sites. Thick fermentation layer developed on soil surface of 15 year-old unclaimed sites. Enclosure experiment indicated low soil mixing in unreclaimed sites. In alder plantations macrofauna, particularly earthworms were more abundant. In the contrary, meso and microfauna displayed lower densities. Presence of earthworms resulted in more intensive soil mixing, and rapid formation of organo-mineral topsoil. However, older unclaimed sites become colonized by earthworms which resulted in rapid formation of organo-mineral topsoil. This also contributed to changes in understory vegetation. In conclusion spontaneous succession may be in some cases a sensible way to restore post-mining sites. Soil formation is strongly affected by soil biota development namely earthworm colonization. Maintaining conditions, that support soil fauna development, may accelerate soil formation.
Role of belowground processes in soil formation and restoration success
Frouz, Jan
Institute of Soil Biology BC ASCR, Czech Republic

This contribution summarizes long term research dealing with development of soil biota in severely disturbed habitats where topsoil was completely removed and soil has to develop de novo or be restored completely. Various approaches have been used in restoration from just allowing spontaneous succession to various efforts to speed up plant development, such as inoculate soil biota either by specific inoculation of specific organisms or by sod or soil transfer, modification of substrate physical and chemical properties, and spreading topsoil from donor sites. Each of these techniques has some ability to improve soil condition, but also bring some risk which may in certain circumstances neglect the benefits of whole operation. For example spreading topsoil may create all topsoil layer in one step, bringing complete soil biota community. However the effect can be reduced by storing topsoil before use, which may effect soil biota composition, produce rapid decomposition of organic matter which promotes nutrient release and together with application promote soil compaction on donor site.

Evaluation of different chemical procedures to phytoremediate hydrocarbon-contaminated soils
(Patagonia, Argentina)
Fuchs, Julio; Jorge Luque, Gustavo Zuleta
Universidad de Buenos Aires, Argentina

Soil pollution due to hydrocarbons (PH) spills is one of the most serious environmental impacts of the oil industry in arid ecosystems of Patagonia. Since remediation solutions are a priority measure for the sector, we investigated the performance of alternative chemical procedures in phytoremediation experiments to determine which parameters better reflect HC degradation over time. A three-factor experiment was conducted on nursery infrastructure, being the treatments: plant species (two native shrubs and two exotic grasses, both perennial), fertilization (with or without), and Total PH (TPH) content (4.1% or absent) in soils from coastal temporary watercourses adjacent to Comodoro Rivadavia city (Chubut province). At three different times (start, 180, and 350 days), PH degradation rates were quantified by five techniques: TPH direct injection (GC-FID) and gravimetric methods, discriminated fractions, BTEX, and PAH's. The TPH decreased significantly in all treatments after 350 days. The light fractions (GC-FID) were degraded 80% at the end of the experiment, while the degradation of heavy TPH (gravimetric) was more selective and phytoremediation and biostimulation processes were recorded. The "saturated" fraction was the most reduced by degradation (58-65%), while the aromatic ones decreased 15-33%. PAH's showed phytoremediation performance. The gravimetric method adequately reflected the daily degradation rates unlike the Pr/nC17-Ph/nC18 ratios. TPH gravimetric determination was the method that more accurately reflected both TP degradation and phytoremediation performance of the plants. These results allowed us to develop technical procedures and practical recommendations for arid environments in Patagonia.

Mexico’s response to the Deepwater Horizon Oil Spill: Joint action among the United States and Mexico required for future protection of the Gulf of Mexico
Fueyo MacDonald, Luis; Vladimir Pliego-Moreno, Natalie Rodriguez-Dowdell
National Commission for Natural Protected Areas, Mexico

The Deepwater Horizon Oil Spill, event without precedent worldwide, mobilized Mexico's environmental sector to prevent damages to the ecosystems, natural resources and coastal communities of the Gulf of Mexico. The National Commission for Natural Protected Areas (CONANP) coordinated the response, integrating with other environmental federal institutions an Action Plan consisting of monitoring, training, and damage prevention and mitigation strategies. Several monitoring efforts in the Gulf of Mexico have been conducted and continue to date. The National Ecology Institute has coordinated Mexican research institutes to generate a baseline and detect any presence of hydrocarbons from the Deepwater Horizon platform. Future monitoring activities and toxicology studies should be conducted jointly between the United States and Mexico, to have a common understanding of the oil and dispersants' impact on the Gulf of Mexico. Joint workshops to systematize the monitoring results and identify restoration priority sites along the Gulf of Mexico are required. CONANP focused its efforts to train personnel and coastal communities of the twelve Protected Areas that border the Gulf of Mexico. 27 Immediate Response Centers were established along the coastal States of the Gulf of Mexico. Training efforts to respond to this kind of emergencies should be permanent and conducted on a bi-national level. Efforts to restore the Gulf of Mexico in the aftermath of the Deep
Predicting variable reinvasion pressure in restorations of exotic-plant invaded ecosystems: Field-testing a new model emphasizing propagule pressure and abiotic variation

Gabler, Christopher; Evan Siemann
Rice University, USA

When restoring exotic-plant invaded ecosystems, the rate of new exotic recruitment following exotic removal (reinvasion pressure) can vary broadly between similarly invaded habitats. Invasive species can have diverse effects on ecosystems, and controlling invaders costs money and impacts native communities. Therefore, understanding what determines reinvasion pressure is essential to predicting restoration outcomes and costs and maximizing management efficacy and efficiency. We hypothesize reinvasion pressure is driven by exotic seed abundance and availability of realized recruitment windows (periods permitting exotic establishment determined by abiotic conditions and interspecific interactions). To investigate factors determining reinvasion pressure, we are conducting replicated restoration experiments manipulating soil moisture, native and exotic seed density, and exotic management in 11 sites along a moisture gradient previously dominated by exotic Chinese tallow trees. After two years, site influenced native plant community composition and abundance and tallow germination, survival and abundance. Nested moisture treatments impacted tallow germination and native plant communities. Tallow germination and abundance increased with tallow seed addition. Native seed addition influenced tallow survival and native community structure, and native seed * moisture interactions influenced tallow abundance. To identify predictors of reinvasion pressure we tested for correlations between initial site characteristics and reinvasion pressure, but no reliable predictors have emerged. Overall, moisture regime and propagule availability influenced reinvasion pressure in predictable ways, and evidence suggests adequately long favorable periods permit recruiting tallow to achieve tolerance of relatively extreme average moistures.

A comparison of seed mix design strategies considering climate change

Galatowitsch, Susan
University of Minnesota, USA

The prospect of climate change has focused attention on how to determine whether particular species used in ecological restoration projects are likely to be suited to future environmental conditions. For those species presumed to be suitable, challenges associated with selecting seed sources have also been recognized and are being actively debated. Another critical consideration is the design of seeding and planting mixes, i.e., the composition and relative abundance of species deliberately introduced. In this presentation I compare past advantages and disadvantages of three common approaches to seed mix design: standard mixes, custom mixes, and standard mixes with augmentations or substitutions. I then consider the likely limitations and opportunities of each approach given the uncertainties of future climates. Seed mixes for tallgrass prairie restorations in the midwestern US are used to explore differences among design approaches.

Developing approaches for the restoration of large braided river channels affected by flow alterations and introduced plant species

Galatowitsch, Susan; Diane L. Larson, Jennifer L. Larson
University of Minnesota, USA

Large braided rivers often have very dynamic active channels with short-lived, sparsely vegetated landforms such as point bars, islands, and channel banks as a result of frequent, high energy flood disturbances. These channel forms can become stabilized with perennial vegetation where regulation has altered flow regimes and lengthened the return interval of high intensity events. Channel restoration requires changes to both vegetation and flows. After vegetation is removed, restored flows could presumably again maintain an active channel. Is this the case when the colonizer is an introduced species? We are investigating whether it is possible to reverse encroachment of *Phragmites australis* on the central Platte River in Nebraska (US). Minimizing reinvasion via seed recruitment is likely crucial for accomplishing restoration because the Platte River populations produce viable seed. We conducted an ex-situ experiment to determine the importance of flooding depth and timing of flood pulses on germination and seedling establishment. Very small differences in hydrologic setting created large differences in recolonization risk. On average, 4 cm of elevation difference changed seedling establishment by as much as 83%. Comparing two flood peak times, seedling establishment was 44% lower for the earlier event. Hydrocycling, a flow regime used for
hydroelectric power generation, also substantially reduced Phragmites seedling establishment. We are currently conducting an in-situ experiment of hydrologic factors affecting scour mortality of seedlings that when combined with these results should suggest the extent to which prescribed flow strategies can minimize Phragmites reinvasion risk from seed on the Platte River.

**Restoring a familiar agricultural landscape: Introduction of trees and agroecological management in Joãopolis, São Paulo, Brazil**

**Gandara, Flávio; Marina Souza Dias Guyot, André Toshio, V. Iamamoto, Mariana Grimaldi Dalcio Caron**

University of São Paulo, Brazil

The southeastern region of Brazil is characterized by very low proportion of natural ecosystems. In regions where small family farms predominate, the allocation of areas for forest restoration can cause a significant loss of area for agricultural production. One alternative is the introduction of agroforestry systems that can maintain some agricultural production and allow the return of part of the biodiversity and ecological processes already lost. The study was conducted in Joãopolis, São Paulo, Brazil, where predominate small family farms dedicated to dairy farming and agriculture. The objective was to generate technical/scientific knowledge for the construction of sustainable production systems, with focus on the integration of forestry and agroforestry production systems on small farms. Participatory methodologies have gone through the diagnostic phase, culminating in the construction, implementation and evaluation of experimental areas of production systems that aim at reducing production costs and increasing the sustainability of family production units, by increasing biodiversity and diversifying production. Four forestry/agroforestry models were developed: agroforestry system with coffee, silvopastoral system, diversified agroforestry in riparian area and forest system with eucalyptus, distributed in 10 experimental plots in six different properties. The properties showed a significant increase in forest cover, especially in steeper areas and riverbanks. The diversity of native species was variable, reaching trees 32 species in some situations. The participatory method and the experimental areas have contributed to a change in the view of farmers showing the possibilities of integration of agriculture and ecological restoration.

**Biodiversity recolonization in a chronosequence of tropical forest restoration areas, in São Paulo state, Brazil**

**Gandara, Flávio; Andréia Caroline Furtado Damasceno, Flávio Bertin Gandara, Paulo Yoshio Kageyama**

University of São Paulo, Brazil

Despite the advancement of knowledge and techniques for restoration of tropical forests, the reintroduction of many groups of plants and animals is not performed normally due to poor knowledge about these organisms or because they are not priorities in the recovery of forest structure. However, it is often observed that some species do not recolonize areas in restoration, even after long periods. This study aimed to describe the soil macrofauna, lianas and epiphytes in three different restoration areas, constituting a chronosequence of tropical forest restoration in São Paulo state, Brazil. These areas were planted with a mix of regional native tree species, aging 6 years (1998), 11 years (1993) and 16 years (1988). For each area, three sampling plots of 900m² were located and its forest structure analyzed. Every tree with CBH ≥ 15cm was observed for presence or absence of lianas and epiphytes. Five top soil samplings of 25x25x25cm were taken from each area during the dry and rainy season, allowing soil macrofauna community evaluation. The forests showed a biodiversity enhancement, except by the epiphytes. Soil macrofauna and lianas were more effective on recolonization of these areas, presenting a maximum of 18 macrofauna taxonomic groups and 13 lianas species and population sizes compatible to natural forests. Epiphytes were almost absent in the study. Despite of the reestablishment of some groups, the biodiversity in these areas still represents part of the original diversity and demands more researches about population dynamics and techniques of reintroduction, especially for some groups, e.g. epiphytes.

**Changes in vegetation along restoration time: Influence of composition and diversity of planted trees on natural regeneration**

**Garcia, Leticia; Richard J. Hobbs, Danilo B. Ribeiro, Jorge Y. Tamashiro, flavio A. M. Santos, Ricardo R. Rodrigues**

Unicamp, Brazil

Studying plant colonization along a restored chronosequence can be particularly informative in clarifying the influence of trees on the non-tree growth forms. Because we studied sites where the planting process included a high diversity of tree species, we tested if the composition and diversity of natural regeneration after restoration planting
was more related to the composition and diversity of planted trees or to restoration age. Our hypothesis that composition of trees planted can affect the establishment of non-tree species seems to be supported, since we found correlation of tree and non-tree species composition both related to restoration age. Only in the reference forest did we detect a significant influence of mean similarity in tree species composition on non-tree species composition. The sampled tree richness, canopy cover and tree height increased according to restoration age. However, the non-tree sampled richness of all restored sites was half the reference values. Our results show that the planted sites were unable to recover all growth forms, especially climbers and epiphytes, even after five decades of restoration. The likely explanation is firstly that these restoration projects were only planted with tree species, and secondly that these landscapes are very fragmented and this can affect plant colonization between sites. We recommend that in future restoration projects, in any system where fragmentation and degradation influence is strong enough to hamper natural colonization, enrichment of the understory should be undertaken a few years after planting in an effort to recover other growth forms.

**Evaluación de trasplantes y cobertura en el sitio de restauración de Acropora palmata en la zona centro del arrecife Anegada de Adentro del Sistema Arrecifal Veracruzano**

García Salgado, Miguel Ángel; Gabriela Georgina Nava Martínez, Miguel Ángel Román Vives, Marcos A. Rangel Avalos, Claudia Le Clercq, Israel López Huerta

Oceanus, A.C., México

El programa de restauración de Acropora palmata del Parque Nacional Sistema Arrecifal Veracruzano inició en el año 2007 después de la evaluación de sitios impactados por encallamientos y zonas donadoras. En el 2008, se instalaron los primeros viveros de coral para estabilización de fragmentos para ser posteriormente trasplantados en el arrecife. En el 2011 se cuenta con más de 3600 nuevos corales creciendo en la zona de restauración del arrecife Anegada de Adentro. Durante esta fase se tomaron datos de altura y diámetro en las colonias trasplantadas, y de cobertura en foto cuadrantes, para observar el crecimiento de las colonias y el incremento en cobertura en el sitio de restauración. Se tomaron muestras representativas a diferentes tiempos para evaluar el crecimiento y condición. El crecimiento promedio de los trasplantes en altura fue de 0.27 cm/mes y en diámetro 0.53 cm/mes, siendo evidente un mayor crecimiento en diámetro. No se observaron signos de blanqueamiento o enfermedades, aun cuando durante la temporada estas especies mostraron blanqueamiento. Solo una colonia se registró con un área pálida causada por predación. Se estima un incremento de cobertura viva de coral de 20 m² en el área de restauración.

**Efecto conjunto de la micorriza y la nodriz a la supervivencia de Mimosa biuncifera Benth. en el parque ecológico Cubitos, Hidalgo, México**

García Sánchez, Rosalva; Bladimir Cuevas Arzate, Iván Hernández Ortiz, Roberto Ramos González

Facultad de Estudios Superiores Zaragoza, UNAM, Mexico

Las especies de los ecosistemas secos poseen estrategias para superar las condiciones ambientales adversas, como la simbiosis con los hongos micorrizógenos arbusculares (HMA), los cuales se asocian al dosel de las plantas; ante el cambio climático, se prevé aumento en temperatura y disminución en precipitación, incrementando la aridez, erosión del suelo y pérdida de propágulos micorrízicos, la suma de estos problemas micorrízicos (HMA) y la pérdida de propágulos micorrízicos (HMA) es una amenaza para la supervivencia de las plantas y favorece la conservación y restauración de la cubierta vegetal. El objetivo del trabajo fue: evaluar el efecto de tres procedencias de (HMA) conjuntamente con el nodrizaje de Opuntia cantabriguensis y Cylindropuntia imbricata sobre la supervivencia de Mimosa biuncifera, previamente propagada y micorrizada con HMA de tres procedencias (Bingu, Gonzalez y Rincón) en invernadero, a los seis meses fueron trasplantadas al Parque Ecológico Cubitos, bajo las nodrizas, las plantas fueron evaluadas mensualmente durante un año, registrando el porcentaje de supervivencia y crecimiento, además de las condiciones microambientales de las nodrizas (temperatura, humedad relativa y luz). Los resultados mostraron respuesta positiva de M. biuncifera a la micorrización; la nodriz C. imbricata favoreció la supervivencia (92%), el microambiente de O. cantabriguensis favoreció el crecimiento (17.82 cm); la procedencia de los HMA afecto significativamente (p≤0.05) la supervivencia y crecimiento de M. biuncifera, la mejor respuesta fue con HMA de Bingu y de Rincón respectivamente, estos sitios fueron extremos en diversidad de HMA. Se concluye que M. biuncifera se estableció mejor micorrizada con HMA procedentes de Bingu bajo la nodriz C. imbricata.

**Avian response to restoration: Traits, time, design, context, and practice**

Gardali, Thomas; Aaron L. Holmes, Christine A. Howell, Nathaniel E. Seavy

PRBO Conservation Science, USA
We have been studying landbird response to riparian restoration in California, USA since 1993. We found that most species responded positively and rapidly to restoration but a few were slow to respond and one declined. Some differences in response can be explained by life-history traits but even more by environmental context including a species population size and its sensitivity to threats beyond amount of habitat. For example, the declining species is heavily impacted by nest failure and is declining throughout its range. Some slow responding species recolonized only after specific habitat conditions naturally developed (debris for nesting crevices, cavities) and population sizes were so low for others that we were not surprised by the rate of response. For species that responded positively, differences in the rate of response can be explained by the amount of existing habitat in the landscape and, for a few, planting design features such as number of tree species planted. We conclude that life history traits related to local scale vegetation were important but perhaps not as important as overall environmental context. Choosing restoration sites in areas with existing habitat will likely improve restoration success for birds. Beyond vegetation, restoration ecologists should consider behavioral traits such as conspecific attraction when evaluating restoration and when trying to ensure and/or accelerate response. Long-term, large-scale studies are needed to parse a slow response from a lack of response and to determine if the shape of the initial response changes over time.

Oak forest restoration in the Mississippi Alluvial Valley - Importance of seedling quality

Gardiner, Emile
USDA Forest Service

The Mississippi Alluvial Valley (MAV), an 8.4 million ha physiographic region flanking the lower Mississippi River, has experienced nearly 80% deforestation for development of agricultural crop production. Though deforestation of the region began in the 1700s, it has only been in the past couple of decades that conservation interests have motivated afforestation efforts to initiate forest restoration in the region. Afforestation in the MAV is primarily aimed at establishing a diversity of oak (Quercus spp.) species native to the alluvial floodplain, but efforts to establish oak plantations can be hindered by poor seedling quality. Research is underway to identify morphological characteristics of seedlings that can serve as indices of outplanting success. This presentation will examine aspects of seedling morphology that contribute to successful establishment of oaks, particularly factors that reduce transplant stress when seedlings are planted on former agricultural fields. Identification of morphological characteristics that reduce transplant stress should aid nursery growers in developing target seedlings, and provide indices of potential seedling survival and growth to afforestation managers.

11 años de trabajo comunitario restaurando ecológicamente los humedales altoandinos del
Municipio Rangel, Estado Mérida, Venezuela

Gaviria, Juan; Ligia Parra, Nidia Parra, Michel Delens
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Luego de una preocupante merma en el aporte de agua para los Sistemas de riego y acueductos para consumo humano, la Comisaría de Ambiente del Comité de Riego de la Comunidad de la Misintá, propuso un plan de restauración ecológica de los humedales cercanos utilizando técnicas de restauración ecológica activa y pasiva y recuperación de los saberes ancestrales. Los positivos resultados, la situación de deterioro en el abastecimiento de agua en todo el municipio y sus súbditas instituciones comunitarias se conjugaron para el establecimiento de un movimiento que incluye a todos los agricultores del municipio, asociados a los 42 comités de riego y más de 3000 asociados en un proyecto de gran envergadura con 169 sitios de restauración hasta la fecha. La restauración se lleva a cabo con participación de todos los integrantes de la comunidad, incluyendo niños, escuelas, liceos, universidades, agricultores, amas de casa, buscando restaurar los valores de las culturas ancestrales, el respeto y el amor por la madre naturaleza, para dejar un legado de amor y esperanza a las generaciones futuras. Los sitios de restauración incluyen pantanos, lagunas, bocas de nacientes, humedales y el cuidado de las microcuencas de la cuenca principal del río Chama. Se le dedica especial atención al componente de educación ambiental y asistencia técnica a los productores, para fomentar el resguardo, cuido y veneración de los humedales, la agroecología, el uso de plantas medicinales, los huertos familiares, sin agroquímicos, orgánicos.

Transforming realities: Integrated coastal zone management (ICZM), connective art, and sustainability

Geis, Tanja
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Integrated coastal zone management (ICZM) initiatives often do not fulfill their goal of holistic and sustainable management of the coastal zone. One reason, according to recent literature, lies in the multi-stakeholder participation process. The process strives to instill stakeholders with a deeper understanding of the meaning and implications of sustainability. Having undergone this transformation of worldview, they should deliver decisions accordingly. Yet for most of us in the west, to perceive the world as such, may require a paradigmatic change from one rooted in reductionism to one more in line with complex systems theory. Connective art might be defined as the creation of a space for transformation through engagement/dialogue between people, and between people and the non-human environment; and which is guided by an ethical intent, directly or through enchantment, to effect positive change. While sharing many of the same principles of ICZM stakeholder forums, connective art spaces often possess qualities of discursive, inter-subjective exchange not commonly found in ICZM practices. These include unconventionality of space, experimentation and play, creative framing of issues and questions, attendance to emotions and feelings, imaginative visioning, direct interaction with the non-human environment, and two-way dialogue between participants and the non-human environment. Introducing these connective art qualities into an ICZM space of engagement has the potential to generate new, collectively realized knowledge, and contextualised redefinitions of reality that can help stakeholders acquire a more system thinking view of reality, and based on this, deliver more sustainable management decisions.

Propuesta para calcular el potencial de restauración en la ciénaga del Tigre, Yondó, Antioquia, Colombia

Gil Patiño, Nelson Enrique; Leonardo Ceballos, Eduard García

Durante el 2011, para el Humedal Ciénaga del Tigre (municipio de Yondó, Antioquia, Colombia), se calculó el Potencial de Restauración (PR) a través de la siguiente ecuación: \[
PR = \left\{\left(\frac{OA}{n}\right) - \left(\frac{FL+FT}{2n}\right)\right\} + \left\{\left(\frac{PB}{n}\right) - \left(\frac{PSD}{n}\right)\right\} + \left\{\left(\frac{OA}{n}\right) - \left(\frac{PSD}{n}\right)\right\}
\]

Donde: \(OA\): Oferta ambiental, \(PB\): Potencial biótico, \(PSD\): Potencial socio-dinámico, \(FL\): Factores limitantes, \(FT\): Factores tensionantes, \(n\): Número de variables componentes de cada factor. El signo ± demuestra que si la tendencia de lo social es positiva el signo será el positivo, si ocurre lo contrario, el signo negativo prevalecerá. Las unidades del PR se expresan en %; originadas de un estimativo del aporte a un evento de restauración de las variables que conformaron la OA, PB, PSD, FL y FT, calificativo dado por los expertos del equipo de investigación. La escala de valoración fue 0-20 muy bajo, 21-40 bajo, 41-60 medio, 61-80 medio-alto y 81-100 alto. Desarrollando la ecuación se obtiene: \[
PR = \left\{\left(46.2-27.0\right) + \left(45.5-10.8\right) + \left(30.3-15.0\right)\right\}/3 = 23.1\%
\]

Un valor de 23.1%, significa alta complejidad en la restauración de este humedal. Un manejo hidráulico del dique artificial que lo aísla del río Magdalena aminorará los limitantes, pero intensificarán tensionantes como la contaminación tóxica, las especies exóticas de peces, y la bioamplificación-bioacumulación; estos últimos causantes de la degradación del ecosistema.

Importance of effective research communication to improve coal mine rehabilitation in Australia

Gillespie, Melina

Centre for Mined Land Rehabilitation, Australia

With an ever increasing amount of research being undertaken to solve specific rehabilitation problems, and generally improve rehabilitation methods within the Australian resources industry, it is becoming more important for research results to be communicated in a way that promotes positive change. For instance, a large body of information on aspects of coal mine rehabilitation across Australia has accumulated over several decades, and yet this information is stored in numerous locations, is fragmented and often not readily accessible. The loss of this information can lead to some obvious problems, including unnecessary (and costly) repetition of past work, initiation of ill-informed avenues of investigation and an inability to learn from past mistakes. This can result in impediments to opportunities of improvements in mine rehabilitation methodologies. The key benefits of more effective research communication include the identification of genuine knowledge gaps and the utilization of information that already exists to improve procedures surrounding sustainable rehabilitation outcomes. In order to promote best practice rehabilitation, the substantial progress in our understanding of mine rehabilitation issues over time needs to be more effectively communicated to those who are involved in mine planning, operating and rehabilitation procedures. Easy access to and greater comprehension of current scientific knowledge is crucial in the decision making processes of our regulating bodies and industry representatives. This presentation will deal with the importance of knowledge transfer, using a reference database containing information on coal mine rehabilitation in Queensland and New South Wales of Australia as a specific example.
Utilizing limiting factors assessment to identify priority projects for restoration

Glass, Domoni
ENVIRO International, USA

The Middle Columbia River steelhead population was listed as a threatened species under the U.S. Endangered Species Act in 1999 and a recovery plan for the species was completed in 2009. The recovery plan listed 100s of projects to be implemented over the entire population area at a total cost of over $996 million U.S. In general, sufficient information was not available to identify priority projects, so all potential habitat improvement projects that could be identified at the time the plan was developed were listed within the plan. Clearly, a process for identifying limiting factors and priority projects was needed. In 2008, a study was completed in Rock Creek basin, which is one of the smaller basins in the Middle Columbia River steelhead domain. The study documented existing habitat and water quality conditions, documented the distribution of steelhead in the basin, and identified the factors limiting the steelhead population in the basin. The assessment concluded that high water temperatures coupled with low summer stream flow was likely the primary factor limiting the size of the population. Once the primary factor affecting steelhead production was identified, specific locations where improvements could be made to reduce water temperature were identified.

Las políticas públicas de la restauración de manglares en México a través de la Comisión Nacional Forestal (CONAFOR): Limitantes, avances, logros, rezagos y retos

Gómez Lozano, Carmen
Comisión Nacional Forestal, México

El tema de conservación y restauración de manglares reviste de una importancia ecológica, económica, política, social y es de gran interés para la Comisión Nacional Forestal (CONAFOR). Acciones de restauración como la reforestación de manglares, con énfasis en la producción de planta y la siembra, fueron impulsadas a partir del 2004 a través de diferentes instrumentos de gestión con ejidos, comunidades, cooperativas pesqueras, organizaciones no gubernamentales, universidades y otras dependencias de gobierno. Si bien esto constituyó un importante avance para la restauración de los manglares a nivel nacional, todavía se detectaron deficiencias y es a partir de 2007 que se inicia una diversificación de las actividades con una visión más integral de los proyectos de restauración. En 2009, se prioriza un esquema bajo convenios de colaboración, cuyo enfoque asegure resultados en superficies relativamente grandes y con proyectos multianuales. Falta aún consolidar e incrementar los esfuerzos técnicos, presupuestarios y científicos para consolidar políticas públicas en el tema, en base a la experiencia adquirida y los resultados obtenidos, y con una visión integral e interdisciplinaria.

Facilitación entre plantas: Una estrategia para la restauración ecológica del bosque altoandino en Bogotá D.C., Colombia

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Universidad Nacional de Colombia

En cercanías del embalse de Chisacá (Bogotá, Colombia) el bosque altoandino ha sido afectado por la invasión de retamo espinoso (*Ulex europaeus*), una de las principales barreras a la restauración. Como estrategia para recuperar la vegetación nativa y controlar la invasión, se establecieron 52 parcelas con *Lupinus bogotensis* y *Vicia benghalensis* como especies leguminosas facilitadoras, sembradas en tres densidades (81, 16 y 9 individuos por parcela) junto con *Solanum oblongifolium* y *Viburnum tinoides*, especies sucesionales tempranas. Cada leguminosa se sembró con una de las especies de interés. Después de 8 meses de seguimiento, vemos que *S. oblongifolium* tiene mayor y más rápido crecimiento en compañía de *L. bogotensis* en las densidades media y baja mientras que *V. tinoides* crece más lentamente y es beneficiada por ambas leguminosas en la menor densidad. La supervivencia de ambas especies es superior en todas las parcelas donde hay acompañamiento de las leguminosas comparado con las parcelas control. Estos resultados indican un efecto facilitador por parte de ambas leguminosas, principalmente de *L. bogotensis* que por su forma de crecimiento y rápido ciclo de vida, genera mejores condiciones ambientales para favorecer la supervivencia y persistencia de las especies e inhibir la recolonización de retamo. En este ambiente, donde las condiciones ambientales tienden a ser limitantes para la recuperación natural del ecosistema, la facilitación parece ser una estrategia útil para la restablecer la vegetación nativa y la dinámica sucesional.
Wildfires in Andean Araucaria-Nothofagus forests: Understanding their historical variability and ecological role as the basis for its ecological restoration

González, Mauro; Michelle Szejner, Ariel Muñoz, Antonio Lara
Universidad Austral de Chile

Fire plays a key role in the ecology of Andean Araucaria-Nothofagus forests. This work illustrates the importance and utility of understanding the fire ecology and the historical reference conditions to guide ecological restoration. Catastrophic fires during the 2001-2002 fire season affected vast areas of Araucaria-Nothofagus forests within several Chilean National Parks. This extreme fire season triggered considerable public, political and scientific concern due to the ecological and cultural importance of Araucaria forests, and promoted urgent plans to restore forests recently burned. For the last decade we have collected tree-ring data and monitored burned vegetation to address the following questions: (1) What is the historical variability of fire regimes? (2) What are the post-fire vegetation responses and recovery patterns? Historic fire regimes have varied greatly during the past 300 years being strongly influenced by human activities. Fire history studies, based on tree rings, indicate that the extent and severity of the recent extreme wildfires (February 2002) were not novel events over the past 300 years. Large Araucaria trees are highly resistant to fire, and this species typically survives moderate to high severity events. Small post-fire cohorts of Araucaria may establish, depending on seed availability and the effects of subsequent fires. In contrast, high levels of tree mortality in moderate to high-severity fires are followed by a new establishment of Nothofagus species. Although further critical evaluation is required, restoration efforts should be focused in the reestablishment of the historical fire regimes to promote a forest landscape of higher structural and compositional variability.

Restoration of tropical montane cloud forests in territories of indigenous communities of highland Chiapas, Mexico

González Espinosa, Mario; Luis Galindo-Jaimes, Angélica Camacho-Cruz, Neptali Ramírez-Marcial, Sergio López
El Colegio de la Frontera Sur, México

Forest restoration projects (FRP) involve long-term actions including agreements and compromises to be negotiated among the involved stakeholders, including the academic group. It is not uncommon that externally driven FRP’s that lack a firm basis for the sustained adoption and support by local landholders fail in the short term. We have developed an approach to promote interest in FRP in peasant and indigenous communities of the central highlands and the El Triunfo Biosphere Reserve in the Sierra Madre of Chiapas. To start with we obtain a detailed analysis of the livelihoods of the communities through participatory workshops conducted on their grounds. A first result of these activities imply the opportunity to recollect their needs and aspirations, and an assessment of their assets as human, natural, social, physical and financial capitals, to be fulfilled through the implementation of FRP in their lands. A major interactive element developed has been maps on priority and high potential areas for FRP. Definition of suitable areas for FRP using native tree species chosen by them has been followed by intensive capacity building starting with training activities aimed to local parataxonomists and paraecologists. Initial topics covered in these training efforts include recognition of native tree species in the field, and observations on phenological stages that are relevant for the procurement of the fruits and seeds to be used in establishing local nurseries. We will present results of the application of this protocol and will discuss some of its promising avenues and limitations.

Use of traditional ecological knowledge (TEK) as guidance for restoration of tropical montane cloud forests in Chiapas, Mexico

González Espinosa, Mario; Neptali Ramírez-Marcial, Angélica Camacho-Cruz, Luis Galindo-Jaimes
El Colegio de la Frontera Sur, México

Traditional ecological knowledge (TEK) has been brought about as an important contribution to mainstream ecological restoration concepts and practice. Most frequently, the purported value of TEK to ecological restoration rests on the use of particular practices or species. Yet, less frequently the emphasis is put on such essential inherent attributes of TEK as the high biodiversity that has been used for centuries to support indigenous livelihoods. In developing a strategy for forest restoration in highly diverse tropical montane cloud forest habitats, we have included the utilization of a considerable fraction of the tree diversity that is commonly used by local populations. In addition to strictly ecological criteria related to adaptation and conservation issues, we have explicitly considered the uses and interests of indigenous communities on local tree species to define the species assemblages to be promoted for particular habitats within their territories. Background information and results of this approach obtained over several years in the central and northern highlands of Chiapas and the Sierra Madre de Chiapas will be presented. This
participatory effort is proving helpful in establishing diversified restoration plantations based on low-cost propagation practices aimed to match the productive activities and subsistence needs of the involved groups. Although some possibilities for local development can be envisaged from producing native tree juveniles in local nurseries, a number of social and economical factors add to biophysical elements in challenging the viability of forest restoration if local groups do not make the project their own initiative.

Utilization of *Quercus* species in guiding a strategy for restoration of highland forests in Chiapas, southern Mexico

González Espinosa, Mario; Neptali Ramírez-Marcial, María Magdalena Alcázar-Gómez

El Colegio de la Frontera Sur, México

The genus *Quercus* (Fagaceae) is among the most speciose within the Mexican tree flora, including some 165 species. For the state of Chiapas a recent account includes 28 species of *Quercus* (encinos or robles as they are commonly called in Mexico). A few species occur near sea level, but most of them in Chiapas thrive at 1000-2800 m elevation. In most forests where encinos are dominant (always as forest canopy elements), 2-3 (4) species coexist and form a compact functional group showing more coincidences than differences among them. Encinos regenerate poorly under shade; they depend on canopy openings, forest gaps, or abandonment of small agricultural fields or pastures. Encinos are the major firewood resource for local peasant mestizo and indigenous communities, and the main raw material to make charcoal, one of the few domestic sources of cash income from local markets; their timber is also valued for rustic buildings and tool handles. Yet encinos provide other ecosystem services: cool and humid habitats to an enormous diversity of epiphytes, amphibians, fungi and other organisms, and regulation of forest microclimate and rates of water infiltration and runoff. They may function as nurse plants for other woody species during secondary succession, and therefore can be used as such in forest restoration projects. Short- and long-term forest dynamics models indicate that this truly keystone functional group should guide management and restoration strategies to prevent negative impacts of extensive pine-rise derived from traditional uses, and conventional afforestation with pines and exotics.

Forest landscape restoration and traditional uses by indigenous communities: Lessons from the highlands of Chiapas, Mexico

González Espinosa, Mario; Neptali Ramírez-Marcial, Angélica Camacho-Cruz, Luis Galindo-Jaimes, María Magdalena Alcázar-Gómez

El Colegio de la Frontera Sur, México

The costs and times of forest restoration may conflict with immediate needs and long-term aspirations of poor landholders. Such is the case of indigenous communities in southern Mexico inhabiting areas with outstanding biological conservation values that need to reconcile with rural development. Traditional utilization of timber and non-timber forest resources is locally heavy and widespread in the highlands of Chiapas, recently leading to considerable degradation of their structure and composition; yet, the value of forest restoration initiatives is still poorly appreciated and given a low priority after agricultural options. Yet an appreciation of the value of forest fragments in a patchy landscape by local groups, arising from recognition of their needs and livelihoods, offers an avenue to a sustainable compromise. We have developed a forest restoration strategy with indigenous communities in their complex landscapes. The strategy is based on: (1) starting the project with bottom-up criteria and indicators to fully acknowledge the needs and interests of local groups, (2) using species assemblages that incorporate a large component of the local tree flora, (3) identifying a small group of tree functional groups that may help understand stand dynamics under complex scenarios that consider traditional timber and firewood extraction regimes, (4) training to strengthen local capacities needed in the establishment and monitoring of restoration nurseries and plantations, (5) recognizing that interest and emphasis on forest restoration and land use may change with time. Some encouraging results have been obtained, yet some pitfalls have also been found and deserve discussion.

Restauración ecológica como herramienta para la recuperación del capital natural

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Universidad Nacional de Asunción, Paraguay

En Paraguay la restauración ecológica (RE) empieza a ser reconocida como necesidad desde 2004, iniciándose como tal, a instancias de organizaciones no gubernamentales en la gestión de áreas protegidas y sus zonas de influencia. En el ámbito académico la Universidad Nacional la considera importante incluyéndola en uno de los currículos. A un año del inicio de la discusión sobre la temática en el país, la Política Ambiental Nacional la menciona, al tiempo que
empieza a ser reconocida como herramienta de la misma, a través de su uso como propuesta para recuperación de pasivos ambientales para propietarios de tierras privadas, y de su consideración en el marco legal forestal. En la investigación se analizan el estado del arte en Paraguay; la facilitación de la aplicación de la política forestal y marco legal relacionado a pasivos ambientales con el uso de la RE; la acogida de la RE como herramienta por parte de los propietarios de tierras privadas y manejadores de áreas protegidas; y el potencial de la RE para la recuperación del capital natural, en contexto.

Building capacity to enhance restoration success: A partnership between NOAA and the Society for Ecological Restoration

Goodrich, Kristen
Tijuana River National Estuarine Research Reserve, USA

The partnership is intended to develop and implement a consolidated package of restoration trainings focused on habitats and species of concern within coastal watersheds that satisfy the requirements and standards of the Society for Ecological Restoration (SER) certification program (in development) and National Oceanographic and Atmospheric Association’s (NOAA) National Estuarine Research Reserve System (NERRS) Coastal Training Program (CTP). The trainings will be developed based on emerging science, technologies and approaches, and needs expressed by restoration practitioners. The trainings would be posted on the SER (national and chapter), Restoration Center, and CTP web sites, among others. Annually, training opportunities will occur throughout the coastal U.S. taking advantage of the unique capabilities of the NERRS and they will be open to participants internationally. Representatives from the network of reserves that have identified restoration as a priority at their reserve and among their local decision makers will work with National Marine Fisheries Service (NMFS) regional offices, the Restoration Center, and SER to conduct targeted needs assessments among restoration practitioners to design a training program accordingly. The needs assessments will advertise emerging science and technologies that could be disseminated through trainings if interest is expressed. Results and lessons learned from the initial needs assessment (to be delivered nationally in the United States in July) will be presented at the conference. The needs assessment will also be delivered to SER 2011 conference participants and results will be presented as well. Based on the results from the needs assessments, a recommendation will be made for training opportunities associated with the SER 2013 Conference and chapter meetings to reflect international training needs and opportunities.

Marine ecosystem electrotherapy: Theory and practice

Goreau, Thomas J.
Global Coral Reef Alliance

The biological effects of electrical currents, although known since 1780, took more than 200 years to be applied to marine habitat restoration. Over the last 25 years, low voltage electrical fields in seawater have been found experimentally to greatly increase growth rates of corals, oysters, sponges, seagrasses, and saltmarsh, and increase settlement of almost all attached and mobile marine organisms, including fish and shellfish. They result in highly diverse ecosystems, unlike conventional artificial reefs, as well as greatly increased survivorship during severe environmental stress. This allows maintenance of coral reef ecosystems under conditions, such as high temperatures, that would normally kill them, quickly restoring them in places where there has been little or no natural recovery, and has many applications in mariculture, in particular a new paradigm of sustainable mariculture based on complex ecosystems rather than monocultures. Unfortunately the practically proven benefits have been underutilized because little work has been done on biophysical mechanisms. All organisms make biochemical energy from the flow of electrical currents across membranes, which organisms must spend a large portion of their energy reserves to maintain. By providing an electrical potential in the right range, organisms are able to produce more biochemical energy, consuming less internal resources, allowing their cells to grow and divide faster, and more rapidly repair physical damage. These results have profound implications for greatly increasing ecosystem restoration, and also for more productive forms of mariculture and agriculture better able to adapt to future stresses caused by global warming.

Basalt powder restores soil fertility and greatly accelerates tree growth on impoverished tropical soils in Panama

Goreau, Thomas J.; Marina Goreau, Felix Lufkin, Carlos A Arango, Gabriel Despaigne-Matchett, Gabriel Despaigne-Ceballos, Roque Solís, Joanna Campe
Global Coral Reef Alliance
**Geotherapy: Global Restoration to stabilize CO2 and climate**

**Goreau, Thomas J.**  
Global Coral Reef Alliance

CO2, sea level, temperature, water, soil, agriculture, forestry, and fisheries cannot become sustainable at safe levels without restoring integrated biogeochemical functioning of global ecosystems. Large-scale restoration of degraded habitats is the only viable option: so little intact wild habitats remain that strict conservation is totally inadequate. Merida temperatures have risen for 170 years: minimum temperatures are now where the maxima were! This is only the start of much larger future changes unless we restore global ecosystems to stabilize our planet’s critical life support systems. Restoration is completely missing from the UN Framework Convention on Climate Change negotiations, and continued failure guarantees runaway climate change. The long-term equilibrium sea level for TODAY’S CO2 levels is 23 m (75 feet) above today’s sealevel (Merida elevation is 9 m), and equilibrium temperature is around 15 degrees C (27 F) above today’s value. Both will be higher if CO2 rises further. Technologies needed to stabilize resources at safe levels: including sustainable energy and biochar to sequester carbon (increasing soil fertility, water-holding capacity, and forest and agricultural productivity) are mature and well known. But without large-scale global restoration efforts starting now, they will come too late to prevent catastrophic overshoot. SER, as the organization of the global restoration profession, must take the lead in getting world leaders to stop wasting time in futile talk and mutual blame and start immediate massive restoration efforts in all degraded ecosystems. These must maximize biodiversity, biogeochemical function, nutrient recycling, and natural carbon sequestration, not based on mono-cultures.

**Can we prioritize restoring reefs to grow back beaches and protect coasts from erosion and global sea level rise?**

**Goreau, Thomas J.; Wolf Hilbertz, Azeez Hakeem, Thomas Sarkisian, Frank Gutzeit, Ari Spenhoff, Delphine Robbe**  
Global Coral Reef Alliance

Coral and oyster reefs provide the most effective shore protection because they are growing and self-repairing structures that very efficiently dissipate wave energy before it hits the shore. Beaches and coastlines grow seaward behind them, where they would otherwise retreat. Massive global destruction of most coral reefs and oyster reefs, coincident with accelerating global sea level rise and increased storm intensity, is already causing most coastlines to erode, and will get far worse in the near future. Typical costs for breakwaters and seawalls are $10,000-15,000 per meter. These structures increase erosion in front of them, and eventually collapse and need to be completely rebuilt. We have designed and built electrically charged Biorock coral reefs and oyster reefs, composed of marine limestone rock grown directly out of seawater. These can be of any size or shape, and have turned severely eroding shores into 15 m (50 feet) of growth in just a few years by reducing wave energy before it reaches the shore, so waves deposit sand instead of eroding it. The cost of Biorock reef structures is around an order of magnitude below that of conventional rock and concrete walls, and they greatly increase fish and shellfish biomass and production while restoring biodiversity in degraded and biologically impoverished sites. Furthermore these reefs are growing and self-repairing structures that can keep up with sea level rise, and they can be readily powered by wave, sun, wind, and ocean current energy. Large-scale coastal ecosystem restoration will provide the most cost-effective future shore protection.
Can we prioritize ecological restoration by using indigenous values for the environment? A case study on the use of a TEK-based index of freshwater ecosystem health in the wet tropics of Queensland

Gratani, Monica; James Butler, Frank Royee, Peter Valentine, Damien Burrows

James Cook University, Australia

Indigenous priorities and modalities of environmental restoration may differ from non-indigenous ones due to different values placed on the environment. In Australia there is an increasing need to include indigenous inputs in ecological restoration, but few projects have been initiated to document indigenous values for environmental management, and none have developed a practical tool to empower indigenous people in environmental restoration and management. Our project aims to fill this gap. Our case study is from the Wet Tropics World Heritage Area, in Queensland and adopts a collaborative research approach to ensure a high level of community participation in developing indicators of ecosystem health. The project documented indigenous values for the freshwater environment, developed related TEK-based indicators and combined indicators in a “cultural index of river health” that can be easily integrated with modern freshwater management. The adoption of the index ensures that the indigenous community’s unique perspective on the environment is taken into account when prioritizing ecological restoration. Within the realm of participatory action research our efforts now aim to develop community ranger programs that will adopt the index to prioritize revegetation, pest management and riparian habitat restoration in the study area. Our approach provides ecological benefits for the environment and social, cultural and economic benefits for indigenous communities involved. It also promotes convergence of IEK and scientific knowledge to enhance epistemological pluralism and hence resilience to ecological perturbations. By providing a practical tool for the inclusion of indigenous values, knowledge and people in current freshwater management and restoration the case study suggests an innovative path to prioritize ecological restoration by using indigenous values for the environment.

Cultural differences in economic values for ecosystem service restoration

Greene, Gretchen

Environ International Corporation, USA

The measurement of ecosystem service value requires determination of geographic, temporal, and demographic elements. A different outcome is expected when any one of these parameters changes. For example, an acre-foot of water over the course of a year is very different than an acre-foot of water in during a dry month; a hectare of fertile soil different than a hectare of arid sand. Less attention however may have been paid to the demographic element, which can vary not merely by the numbers of people affected, but by how they use and value the ecosystem service. Though individuals within any group are likely to have heterogeneous preferences, cultural differences may play an important role in understanding how differences in value and use vary from one group to another. These cultural factors can affect results and are also helpful in determining an appropriate approach to be used to measure or estimate ecosystem service values. This presentation will review the literature to date that addresses the issue of cultural differences in ecosystem service analysis and offer guidelines for valuation and quantification tools as applied in different cultural contexts. Topics covered will include property rights, market based economic activity as opposed to subsistence, and religious associations with the natural environment. Views about time may also vary by culture, and influence the appropriate choice of a discount rate if the analysis moves through time. Examples will be drawn from Spain, Alaska, and Mongolia, and others.

Investigación en sistemas de producción rural: Una ruta por explorar en los modelos de compensación biótica por la minería en Colombia

Gualdrón Acosta, Ramón; Kénica Mendoza Ovidio Beltrán, Franklin Carrillo

Carbones del Cerrejón Limited, Mexico

El cambio de uso de la tierra por el avance de la minería a cielo abierto en Colombia produce alteraciones importantes en los flujos de bienes y servicios ambientales para las comunidades humanas asentadas en las áreas de influencia. Cerrejón, empresa minera de carbón que opera en el valle del río Ranchería, Departamento de La Guajira, viene adelantando de desde hace seis años, en tierras de campesinos y comunidades indígenas, un proyecto de investigación en sistemas de producción rural, como medida de compensación social, económica y ambiental. Los objetivos principales son: reversar la desertización en tierras secas, rehabilitar las tierras ya degradadas e incrementar los capitales naturales y humanos para enfrentar con éxito las amenazas del cambio climático. Aplicando los
principios de la investigación participativa se ha conformado un equipo de investigadores locales, con la participación directa de empleados de la empresa y voluntarios de seis comunidades vecinas. En cada comunidad se han caracterizado los indicadores de línea base más relevantes, se definieron las temáticas de investigación pertinentes y se diseñan y monta nuevos experimentos que promuevan la capacidad de innovación en sus integrantes. Después de seis años de persistencia el proyecto comienza a ser abordado por vecinos y grupos interesados. Los temas más avanzados están relacionados con el uso estratégico de los recursos locales: germoplasma, lluvias, suelo y mano de obra.

Rehabilitación de tierras intervenidas por minería de carbón a cielo abierto en Colombia: Caso Cerrejón

Guadarrón Acosta, Ramón
Carbones del Cerrejón Limited, Mexico

La gran minería de carbón a cielo abierto es una actividad relativamente reciente en Colombia. Cerrejón inició sus operaciones en 1983 en el valle del río Ranchería, Departamento de La Guajira, localizado en la Región Caribe, en un ambiente semiárido. Como empresa pionera en el país, le ha correspondido construir toda la secuencia en cuanto a cómo restituir efectivamente la tierra intervenida, cómo evaluar y validar su efectividad y cómo compensar por la disminución en la oferta de bienes y servicios ambientales, debidas al cambio de uso de la tierra. La restitución o rehabilitación de las tierras es un proceso jerárquico e interconectado, bien definido por el orden y rol que juegan las variables conductoras espacio, suelo, energía, agua, carbono, nitrógeno, fósforo y potasio, cada una de ellas determinadoras de las acciones vitales por ejecutar o acompañar durante cada una de las etapas y estados de evolución del proceso. Indicadores de gestión y resultado tales como área intervenida, área en rehabilitación, área activa, material edáfico preservado y reutilizado, sucesión vegetal, estados y tipos de cobertura, cobertura superficial del suelo, conductividad hidráulica del suelo, carbono, leguminosas, fósforo, potasio, composición botánica y repoblamiento faunístico, entre otros, son componentes rutinarios de la gestión ambiental desarrollada en más de 2,800 ha bajo tratamientos, cuyo objetivo es convertirlas en áreas para la conservación.

Defining degradation: Implications for decision making

Guariguata, Manuel; Robert Nasi
Center for International Forestry Research, Indonesia

Ecosystem degradation is an important environmental, social and economic problem particularly in developing countries: estimates of degraded forest lands range from 800 million ha across the tropics up to 1 billion ha including the subtropics. Yet sound decision-making frameworks to either restore or rehabilitate are needed since degradation is difficult to define operationally and because it is perceived differently by various stakeholders who in turn have different needs and objectives. From a local perspective, land managers are usually in need of clarification as to how and when to invest resources to restore a ‘degraded’ area. From a global perspective, clarification is also needed. The recent FAO Forest Resources Assessment could not report on extent and severity of forest degradation due to lack of agreed definitions. Also recently, signatories to the Convention on Biological Diversity agreed to restore 15 % of degraded areas over the coming decade yet lack of operational definitions and indicators of degradation may disorient international donors motivated to fund these global commitments. Furthermore, several international sustainability standards promote the cultivation of biofuel feedstock in degraded lands to mitigate land use change impacts. If clear guidance of what constitutes a degraded area is not provided, gazetting “degraded lands” for biofuel plantations may ignore livelihood and environmental concerns in what looks as abandoned or otherwise unproductive areas. Attempts at operationalizing the definition of degradation from an environmental perspective needs to explicitly address issues of spatial and temporal scale, ecosystem resilience, suitable indicators, and/or management objectives.

Restauración ecológica en zonas urbanas y semi-urbanas con criterios biológicos y culturales

Guerrero, Simón; Daneris Santana
Ministerio de Medio Ambiente y Recursos Naturales, Dominican Republic

Se presentan los datos de un programa a largo plazo de restauración en áreas urbanas y semiurbanas que cumple varios objetivos: contribuir a la conservación de la biodiversidad utilizando plantas que producen alimento y refugio para la fauna nativa y restablecen el vínculo entre naturaleza y cultura mediante la inclusión de plantas con valor etnobotánico, ya sea porque eran sagradas para los aborígenes, formaban parte de su dieta o están asociadas a hechos históricos o tradiciones del país. Tres ejemplares de Ceiba pentandra (que era un árbol sagrado para los Taínos)
fueron sembrados en la “Plaza de España”, en la Ciudad Colonial, un monumento natural que da, como los monumentos arquitectónicos, dignidad y belleza a la zona. Una de las plantas utilizadas (*Piper aduncum*) cumple todos los requisitos del programa: es una planta pionera, sus frutos son comidos por las aves y los murciélagos, son hospedera de mariposas, sus hojas son usadas como repelentes de exoparásitos en las gallinas y con fines medicinales y eran parte de la dieta de los Taínos. En la restauración de humedales, además de aplicar los criterios anteriores, se ganan espacios para el disfrute de los habitantes de barrios marginales y su educación en torno a la importancia de la conservación de la biodiversidad y de los ecosistemas de humedales.

**Restauración de suelos agrícolas por mujeres del ejido “Las Palmitas” del Estado de Guerrero, como alternativa para contrarrestar la deforestación en suelos forestales**

**Guerrero Vázquez, María Esmeralda; Jonathan Franco López, Ezequiel Vidal de los Santos**

UNAM, Mexico

En la localidad de las Palmitas Municipio de Tecoanapa del Estado de Guerrero, debido al cambio de uso de suelo para fines agrícolas y pecuarios así como incendios, plagas y tala clandestina la superficie forestal ha ido disminuyendo, presentándose problemas de deforestación, perdida de micro y macro flora y fauna así como de suelos por erosión. El ejido presenta diferentes tipos de degradación: hídrica, química y eólica. El presente trabajo tuvo como objetivos, la recuperación de suelos agrícolas como alternativa para evitar la deforestación en suelos forestales, así como recuperar la fertilidad de los suelos para el cultivo. Los trabajos fueron realizados en diez parcelas de 3 ha. por mujeres de la localidad, quienes hicieron obras de suelo, para la retención de azolves y captación de agua así como cultivo de maíz asociado al frijol y jamaica, para la recuperación de la fertilidad se compostearon los desechos agrícolas. Como resultados se obtuvo una retención de suelos en un 80% lo cual permitió que se pudiese sembrar en las áreas restauradas. Para que los resultados sean óptimos y continuos es de suma importancia que la rehabilitación pase por una serie de medidas preventivas, correctivas y estructurales, con la participación activa de la población, además de formarse para fortalecer capacidades locales para la planeación., dar seguimiento con monitoreo de avances y continuar con las evaluaciones periódicas del proceso.

**Ecological restoration in protected areas from Ibero-America**

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Instituto de Ecología, A.C., Mexico

The conservation of biodiversity until now has focused on the protection of natural areas and to a lesser extent in the protection of species ex situ. Actually, 12% of the global area is protected. However, an increasing loss of biodiversity in these protected areas has been detected, due to many reasons as land use change around and within reserves, climate change and the spread of invasive species. Natural protected area managers have overlooked the biodiversity that exists in other forms of land use (farmland, urban development, etc.) around them, as well as the relationship of this biodiversity with the natural component. The management of natural areas disregards the landscape concept and devotes their efforts to conserve the biodiversity in undisturbed areas. In this scenario, ecological restoration should be based on the cultural and biological diversity of the region. The restoration challenge is to transcend the boundaries of the protected area, assume the disturbance and experiment with the landscape structure and function. Restoration should weave the ecological processes of ecosystems with sustainable development and food security, thus expanding their influence to whole regions.

**Microcorredores como estrategia de restauración y conservación de la diversidad biológica en cultivos permanentes**

**Gutiérrez Beltrán, Néstor; Juan Gaviria, Manuel Luján, Marina Mazón, Guillermo Bustos, Grégory Delourme**

Instituto de Investigaciones para el Desarrollo Forestal, Venezuela

La simplificación y tecnificación de cultivos permanentes, como el cacao, resulta en la pérdida de biodiversidad con problemas en el funcionamiento y sanidad del cultivo. Para revertir tal situación se ha desarrollado el proyecto Cacaoicultura en Ambientes Biodiversos para la Sustentabilidad (CAMBIOS), fundamentado en un plan consensuado de restauración ecológica en la Finca el Pedregal, al Sur del Lago de Maracaibo, Venezuela, destinada al cultivo de cacaos criollos. La estrategia de restauración propone crear pequeños corredores biológicos que permitan el restablecimiento de la biodiversidad en áreas de cultivo, que conmute pequeñas áreas de bosque destinadas a la conservación. Se aplicó estrategias de restauración pasiva en corredores de ancho variable (2 a 5 m), y se está realizando el monitoreo del avance en parcelas permanentes de 50 m² (25m*2m) con mediciones semestrales. Luego de 2 años se ha logrado el establecimiento de una red de corredores de 16 km con una superficie estimada de 5 ha. Se
ha registrado el establecimiento de más de 30 especies leñosas, en su mayoría pioneras, pero con la aparición progresiva de secundarias durables comunes en el bosque húmedo tropical, ausentes o muy poco frecuentes en las áreas bajo cultivo. Los resultados preliminares muestran un gran potencial de los microcorredores en la recuperación de la biodiversidad en el cultivo sin afectar las áreas productivas, y se espera beneficios diversos al cacaotal que están siendo monitoreados.

**Humedales: Restauración ecológica para la producción, la conservación y el hábitat digno de los territorios de gente de agua y tierra**

Gutiérrez Camargo, Juan Carlos; Ernesto Montenegro

Fundación Alma, Colombia

El río Magdalena, principal cuenca de los Andes, se encuentra en una grave crisis ecológica. La reducción drástica de los recursos hidrobiológicos, la disminución abrupta de la pesca, la sedimentación descontrolada, la pérdida de sus bosques riparios, el fraccionamiento de ecosistemas de humedales asociados, las inundaciones y los desastres, son indicadores de un desastre del modelo de pensamiento y sociedad más allá de un fenómeno natural. El trabajo en el Magdalena Medio ha demostrado que el modo de producción de la sociedad de pescadores artesanales y la estructura de pensamiento que han cultivado centenarioamente contiene las claves para la restauración de los ecosistemas del agua que las llanuras aluviales conforman. Se concibe la restauración ecológica como una llave para el ordenamiento social y ambiental de hábitats dignos a las comunidades y municipios devastados, bajo la compresión y adaptación a la naturaleza, en el entendimiento telúrico de la dinámica y crisis actual de las cuencas hidrográficas, de los complejos de humedal y sus ecosistemas asociados, en su oficio como reguladores y dañores de la energía del agua, el suelo, el aire y las comunidades que los habitan. La emergencia por inundaciones y deslizamientos de laderas no es por el agua o el desmesurado invierno, se provoca en cada acción de asalto e interrupción de las dinámicas esenciales para ecosistemas que son tan ricos como frágiles. Transformar esa matriz de relación entre sociedad y la naturaleza es parte de las decisiones que como generación debemos abonar en el pensamiento sobre un futuro sustentable al común de sus pueblos, sectores y territorios.

**Soil fauna structure and composition in early aged road slopes using experimental treatments**

Gutiérrez López, Mónica; Sandra Marta Magro, María Dolores Jiménez, Dolores Trigo

Universidad Complutense de Madrid, Spain

Road construction produces an increase of degraded areas with severe erosion and loss of natural soil fertility. Relationships between decomposer communities, as well as soil arthropods, and human perturbations are poorly known but their study can be an important tool in determining the evolution of the soil characteristics from these areas. The aim of this study is to evaluate the structure of soil arthropod communities and the physical and chemical properties of soils at roadcuts. The experimental set up was carried out in a highway near Torres de la Alameda (Madrid, Central Spain). We established four experimental treatments with three replicates each: (1) control, (2) soil tillage (3) topsoil spreading and (4) soil tillage + topsoil spreading. Each treatment was compared with samples from two neighboring agricultural systems: (1) fallow land and (2) olive grove. Soil samples were taken in plots of 25 x 25 cm from two levels of depth (epigeic and endogeic). Microarthropods were extracted through the Berlesse-Tullgren method and physical and chemical analyses of soil were made. Fallow land and olive grove stands had the highest number of arthropods showing a great decrease in soil fauna caused by roadslope construction. Several Coll embola and Acari families (Sminthuridae, Passalozetidae, Galumnidae and Uropodina) as well as other groups of arthropods (Pseudoescorpionida, Pauro poda, Sin filia, Geofilida, Litobida, Protura, Japijida, Diptera, Lepidoptera, Himenoptera and Hemiptera) which appeared in fallow land and olive grove stands, they did not show in any of the roadcut treatments. Some typical epigeic arthropods were found in deep levels showing a deconstructed soil fauna community.

**Development of decomposer edaphic fauna and soil properties at roadslope**

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Road construction is producing an increase of degraded environmental areas that show severe erosion leading to the loss of natural soil fertility. Structure and function of these systems are strongly influenced by biotic interactions. Some soil arthropods are part of the decomposer biota ensuring the decomposition of organic matter into the soil and increasing the surface area of plant detritus and of the cast deposition to microbial attack. Thus, more attention should be paid to these groups of arthropods which are usually used as indicators in soil quality evaluation, and
therefore, an important item to be included in restoration ecology research. The aim of this study is to evaluate the development of the diversity and the structure of soil arthropod communities in relation to physical and chemical soil properties at road embankments. This study took place in two highways, the M-12 and M-13 near Barajas Airport (Madrid, Central Spain). We selected six embankments with different vegetation cover. Annual samples were taken during two years (spring 2009 and 2010) to extract soil arthropods from two levels of depth (epigeic and endogeic). Physical and chemical soil properties (structure, texture, %C, %N, C/N ratio and pH) were analyzed and the vegetation cover estimated. The influence of soil system development was evaluated by (1) the description of major taxonomic and functional groups of soil arthropods (2) the description of physical and chemical soil properties and (3) the study of the effect of the different vegetation cover on the structure and diversity of decomposer, as well as on the physical and chemical soil parameters.

**Model targets for restoring anthropogenic fire to sustain oak ecosystems**

**Guyette, Richard; Michael Stambaugh, Daniel Dey**

University of Missouri, USA

Oak abundance and diversity in ecosystems are driven by many factors. Here, we examine the influence of climate, fire, and anthropogenic ignitions on oaks. Both case studies and modeling approaches are used to quantify the influence of human population, culture, climate, and fire on oak ecosystems. A conceptual model of oak ecosystems is presented based on associations between oak ecology, human culture and population, climate, and the physical chemistry of fire. Both climate and fire are found to be integral parts of human and oak ecology. Evidence is presented for humans as a natural ‘fire species’ that has influenced the abundance of oak in many parts of North America for thousands of years. Modeled and mapped fire frequency, oak abundance, oak diversity, and historic human population reveal these associations. Recent reductions in the frequency and severity of fires through fire suppression and land use have reduced the competitive advantage of oaks in ecosystems that once had strong anthropogenic fire regimes and oak components. The restoration of oak species should be enhanced by anthropogenic warming but will be made more difficult by land use patterns and fire suppression. Fire frequency models show that oak abundance and species diversity flourish in fire regimes with mean fire intervals between 3 and 17 years.

**Éxito de árboles provenientes de reclutamiento natural y propagados en vivero en plantaciones de restauración**

**Guzmán Luna, Alejandra; Cristina Martínez Garza**

Instituto de Ecología, Universidad Nacional Autónoma de México

La siembra directa puede ser una alternativa viable para la restauración ecológica. Es más económica que las tradicionales plantaciones de individuos propagadas en vivero. Características de arquitectura y otras que reflejen aspectos fisiológicos, son parámetros que utilizamos para predecir qué especies son candidatas para la siembra directa y cuáles para el trasplante. En el año 2006 se establecieron plantaciones con 8 pioneras y 16 no-pioneras en un pastizal activo aledaño a la Estación de Biológica Tropical Los Tuxtlas, Veracruz, México. Estas especies se sembraron en 16 de 24 parcelas experimentales, de 30 x 30 m: 8 parcelas fueron sembradas con especies dispersadas por viento, 8 con especies dispersas por animales, y 8 fueron dejadas sin plantación como control. Hasta ahora se han realizado 13 censos de crecimiento y sobrevivencia de los individuos plantados cada 6 meses y censos de todos los reclutas cada 4 meses. Para el presente análisis se trabaja únicamente con 17 especies, del total de las plantadas y reclutadas: 10 no-pioneras y 7 pioneras. Es posible identificar diferencias significativas en sobrevivencia entre las especies reutilizadas naturalmente y trasplantadas de vivero \((t=2.59, P<.05)\). No se encontraron diferencias entre parámetros de crecimiento \((t=.912, P<.05)\). Las especies pioneras no presentan diferencias en sobrevivencias \((t=1.96, P<.05)\) respecto a las no-pioneras, pero sí presentan una altura significativamente mayor que las no-pioneras \((t=2.42, P<.05)\). Con base en las características cuantificadas, se identificarán grupos funcionales: a cada uno se le asignará la mejor opción de establecimiento (siembra directa o trasplante de vivero). Cada especie arbórea de la selva alta podrá insertarse en un grupo funcional.

**The Finnish best practice toolbox of peatland restoration**

**Haapalehto, Tuomas**

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In Europe alone, human actions have impacted 60 % of the original peatland area through agricultural, forestry and peat extraction activities. Peatland degradation has been especially extensive in Southern Finland, where 75 % of the
original peatland area has been drained for forestry. Drainage changes the hydrology of peatlands profoundly. Hydrological changes are reflected in the species composition of the drained peatland ecosystems as original peatland species decline and forest species take over. Ultimately, the degradation of peatland ecosystems causes a significant threat to the international goal of achieving a reduction in the current rate of biodiversity loss. 17,000 ha of drained peatlands have been actively restored in Finnish conservation areas since 1990s. The aim has been to initiate a process that will restore functional peatland ecosystems and species characteristic to these habitats. The Finnish best practice toolbox of restoration includes damming and filling up the ditches with peat and the removal of trees grown after drainage. The toolbox also includes carefully planned research and monitoring. Qualitative general monitoring is carried out on all restored sites to make sure that the restoration process is activated. A nationwide monitoring network has been established to gain quantitative results on the ecological effects of restoration on vegetation, hydrology and butterflies. Spatial conservation prioritization methods, e.g. Zonation, will be added to the Finnish best practice toolbox in a few years. The prioritization methods will enable targeting of restoration measures to areas where the ecological benefit gained is highest and financial cost lowest.

Long distance dispersal in macroinvertebrates as a prerequisite of climate change driven range shifts and recolonization of restored rivers

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Climate change driven range shifts or the recolonization of restored habitats can only be realized by organisms with a sufficient dispersal capacity. Several studies consider short distance dispersal, whereas our knowledge about long distance dispersal of macroinvertebrates is scarce. This is mainly due to a growing “dilution effect” with increasing distance. To overcome this dilution effect, we present the results from three complementary approaches: 1) data mining, 2) a literature review on macroinvertebrate dispersal, and 3) population genetics. Dispersal strategies were categorized in active and passive, and sub-classified in aquatic, aerial, and terrestrial. We further distinguished between within-stream and between-stream dispersal and also assessed the speed of dispersal by providing dispersal distances in kilometer per year. All three approaches provide relatively short distances for hololimnic taxa and aquatic larvae of merolimnic taxa. Even adults of winged merolimnic taxa usually only move short to intermediate distances, although there are a few reports of occasional historical or recent long-distance dispersal. The results thus support the idea that the spread of, and quick recolonization by, macroinvertebrates usually is limited by their dispersal capability in addition to potential habitat filters in restored sites. Dispersal limitations can be overcome by using aquatic, aerial, or terrestrial vectors (passive dispersal). Our results point to the need of advanced river restoration strategies that integrate and facilitate landscape-wide networks. Concerning climate change, our data could be used in advanced species distribution modeling (SDM) to improve our knowledge of climate change driven macroinvertebrate range shifts.

Ecology in practice: The poetics of transdisciplinarity

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Setting the context for the Symposium, ‘The Art of Ecology: Transdisciplinary Research in Practice’, this paper reflects on the growing number of artists, designers, architects, and social scientists who integrate ecological principles in their practices. It is particularly concerned with the poetics, or ‘making’ processes of transdisciplinarity. The value of ecology may be understood as the emergence of its parts, or ‘whole system’. Loss of a part means the loss of that system, so interdependence must be understood as integral to the whole. This notion stands in opposition to the post 2005 language of ‘ecosystem products and services’ that reduces species to expendable entries in a cashbook account and biodiversity to consumer choice on a supermarket shelf. Given this impasse, how might we shift our culture and the science it supports from ‘market economies’ to ‘growth ecology’, the primary aim of restoration science, management, policy and education? While ecological restoration offers creative opportunities for interdisciplinary collaboration, new forms of practice remain constrained by industry, commerce, politics and academia that insist on classical disciplines of knowledge. So, how may these institutional and personal ‘flat-earth’ approaches be resolved by the arts that address this ‘ecology in action’, or culture for extinction? How might both arts and sciences learn from ecology? Critical analysis and art theory tend to focus on the aesthetic and sociological aspects of arts practice, but what are the new forms of creative practice emerging from the ecology of disciplines engaged in restoration?
Conservation actions in response to demographic decline: An experimental augmentation of *Dicerandra christmanii*

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Long-term demography on rare species provides science-based management guidelines for conservation including species specific actions and habitat management. With this goal, we studied *Dicerandra christmanii*, a critically endangered plant species on the Lake Wales Ridge, an ancient sandy upland in peninsular Florida and biodiversity hotspot with several dozen endemic species. We collected *D. christmanii* demographic data for 16 years at Flamingo Villas, its only protected site, observing a steady population decline. Annual survival dropped over recent years with a record low in 2009. We also observed highly variable, but also recently poor recruitment. These declines are likely related to weather variations (e.g., precipitation) and lack of habitat management. Typically found in gaps within shrub matrices in xeric scrub, *D. christmanii* prefers open microhabitats historically maintained by fire. Scrub at Flamingo Villas is mostly overgrown and unable to support *D. christmanii*; most plants grow along fire lanes and old roads. To reverse these trends, we initiated an experimental augmentation, designed to evaluate the efficacy of three different plant materials (seeds, greenhouse-grown seedlings, greenhouse-grown stem cuttings) and to identify favorable microsite conditions for *D. christmanii*. To date, we have observed 3% germination for introduced seeds, high six-month survival for transplants (89% for seedling transplants and 70% for stem cuttings), and 34 second-generation seedling recruits from fruiting transplants. We will continue to monitor this experiment and compare vital rates between the introduced population and adjacent wild populations, hoping to provide additional research-based recommendations for *D. christmanii* conservation.

**Novelty value: Intervention ecology and making the most of novel ecosystems**

**Hallett, Lauren; Richard J. Hobbs, Paul R. Ehrlich, Harold A. Mooney**

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Novel ecosystems, characterized by new, non-historic species configurations and/or new abiotic settings, are on the rise due to increased biotic change (invasion and extinction) and abiotic change (particularly land use and climate change). These no-analog systems are both inevitable and may also contain desirable elements and provide essential ecosystem services. Hence increasingly we need to think of a range of approaches to ecosystem management. Restoration may be better viewed under the umbrella of a new ecology, "intervention ecology," that focuses on meaningful interventions in ecosystems aimed at maintaining or increasing valuable attributes of both historic and emerging novel ecosystems rather than always aiming to maintain or restore specific historic states. Interventions can include altering the biotic and abiotic structures and processes within sites. Successful interventions, however, may also require consideration and modification of how sites relate to surrounding matrix habitat and how they are viewed by overarching social and policy settings. Interventions can be aimed at leverage points, both within ecosystems and in the broader landscape and social system, particularly feedback loops that either maintain a particular state or precipitate a rapid change from one state to another.

**Use of recovered, restored, and regenerated oak forest ecosystems by wood warblers in the Western Hemisphere**

**Hamel, Paul; David A. Buehler, David King, Claudia Macias Caballero, Kathryn Purcell, Scott H. Stolesen**

USDA Forest Service

Oak forests, important North and Central American ecosystems, support numerous migratory and breeding birds. We review the use of oak forests by the avian family Parulidae, including about 115 Neotropical and North Temperate species. Among three listed as endangered by the U.S. Fish and Wildlife Service, Golden-cheeked Warbler (*Dendroica chrysoparia*) depends upon oak forest ecosystems for nonbreeding habitat and Bachman’s Warbler (*Vermivora bachmani*) associated with cane (*Arundinaria gigantea*) stands in mixed oak bottomland forests. Two of 18 additional species also listed by IUCN in some category of vulnerability are long-distance migrants, Golden-winged Warbler (*Vermivora chrysoptera*, IUCN Near Threatened) and Cerulean Warbler (*Dendroica cerulea*, IUCN Vulnerable). Central American resident Pink-headed Warbler (*Ergaticus versicolor*, IUCN Vulnerable) and several migratory warbler species depend upon oak forests and associated ecosystems. Resident warblers of the northern Andes use oak forests as well, as do many other species. After extensive harvest of North American oak forest ecosystems in the late 19th and early 20th centuries, members of Parulidae faced great changes in occurrence, distribution, and age structure of oak forests. Current habitat use by these species is a reflection of response to past
wholesale changes in their oak forest habitats, and a guide to potential responses to restoration and management activities purposely conducted in oak forests in future. These birds may provide a model for how oak forest ecosystems may be restored and managed to provide suitable habitats for the species and to provide other products sustainably.

**Achieving ecosystem scale oyster reef restoration through a national partnership with NOAA’s community-based restoration program**

Hancock, Boze; Robert D. Brumbaugh, Michael W. Beck

The Nature Conservancy, USA

Filter feeding bivalves, particularly oysters, have the ability to regulate the functioning of nearshore ecosystems. Oyster reefs have also become a globally imperiled habitat. Because of the importance of bivalves as ecosystem engineers and the scarcity and continued exploitation of the habitat they create, the Nature Conservancy (TNC) has been actively involved in conservation and restoration of shellfish habitats for over a decade. Since 2001, TNC and NOAA’s Community-based Restoration Program have partnered to restore habitats critical for the marine resources of the U.S., funding nearly 120 projects including 60 shellfish restoration projects. Projects have targeted clams, oysters, scallops and abalone with the majority focused on restoring habitat of either Olympia (Ostrea conchaphila) or Eastern oysters (Crassostrea virginica). The partnership has been a major contributor to the development of restoration techniques and methods of measuring success that have propelled shellfish restoration. The partnership’s projects have been selected to raise the profile of the ecosystem services provided by bivalves. Documenting the poor condition of most exploited shellfish species and the beneficial services they provide has been important for influencing policy and decisions about management of shellfish reefs as habitat. The proof-of-concept projects have also laid the foundation for larger scale projects bringing shellfish restoration to ecologically meaningful scales. A summary of achievements to date, mechanisms for increasing the scale, and possible future directions for shellfish restoration will be presented.

**Dreams and nightmares of restoring urban habitats**

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Small patches of native habitat in urban and suburban areas can supply ecological services, public amenities that are sustainable with relatively low maintenance costs. We have designed and tested a series of plantings in urban areas (parks, landfills, and brownfields) that attempt to restore ecological connections between fragmented and degraded remnant habitats. Projects on old urban landfills used woodland patches of various scales showed that mutualisms, including seed dispersal, pollination, and mycorrhizal infections can occur quickly. Urban bee diversity can be high, even on degraded sites. Also, special genotypes of plants may be needed to persist under urban stresses. Experiments show that mixtures of local genotypes have the best probability of surviving in urban plots, which are heterogeneous. Many urban habitats in the northeastern North America are degraded by deer overpopulation and by invasive plant species. Remediating these habitats requires deer and invasive control, fencing, and public education programs. Restoration designs for the new Brooklyn Bridge Park in New York and the Orange County Great Park in California includes meshing restored habitat complexity with civic needs. These types of ecological solutions may be relevant to many urban landscape architecture designs. Extensive and early collaboration with the design professions, landscape architects, planners, and civil engineers, is needed for these plans to succeed. Building this link with the design community will be necessary to advance urban restoration practice.

**The efficacy of watershed rehabilitation programs in restoring rangeland, seep, and wet meadow systems in the highland Andes – The social and biophysical factors**

Hartman, Brett

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Many arid and semi-arid tropical montane zones managed by traditional societies have undergone a cycle of poverty, land degradation and gully erosion. Restoring these lands through concomitant investments in ecosystem restoration and community development offers a promising new approach to address this problem. The current research is a quantitative evaluation of the social and biophysical factors that influence land restoration, using a watershed rehabilitation project in the highland Andes. Encompassing 24 Aymara communities on the eastern Cordillera of Bolivia, a system of grazing enclosures and 30,000 – 40,000 check dams, terraces, and infiltration ditches have been built since 1992. Specific objectives include restoring vegetative cover in dry Puna grasslands, and increasing
groundwater recharge for seep, wet meadow and riparian systems vital for dry season grazing. Results from the current remote sensing phase of the study will be presented. Using a time-series (1986 – 2010) of Landsat TM, ETM+ and ASTER images, changes in biomass production were measured using Spectral Mixture Analysis (SMA), and changes in the extent of dry season soil saturation and inundation were measured using terrain analysis, ETM+ and ASTER thermal bands, and select visible and infra-red spectra (Bands 2, 5 and 7). Time permitting, preliminary results of the follow-on research will be presented, including household surveys to evaluate the effectiveness of farmer-scientist collaborations to rehabilitate indigenous knowledge systems, and balancing institutional and community development factors with exogenous pull factors such as off-farm labor to increase project success.

**Socio-economic conditions of Marsh Arabs in the Mesopotamian marshlands**

**Hasan, Nabeel Abdul**

*Nature Iraq*

The marshlands of Mesopotamia have been home to ancient human communities for more than five millennia. The area’s inhabitants are commonly known as the Ma’dan or “Marsh Arabs”. Their settlements were located on marsh edges or on artificial floating islands that are regularly reinforced with reeds and mud. Water-buffalo play a pivotal role in Marsh Arab existence. Fishing, waterfowl hunting, and rice and millet cultivation provide a subsistence economy; reeds provide food for water-buffalo and building materials for dwellings. Reed mat weaving is another income-generating activity, which is exported to markets throughout Iraq. With the outbreak of the Iran-Iraq war in 1980, their homeland was transformed into a frontline combat zone. Subsequently, they faced a marshland drainage program in the early 1990s that ultimately shattered their society and way of life. Efforts by local citizens and the Ministry of Water Resources resulted in re-inundation of various portions of the marshlands after the commencement of the second Gulf War during 2003. In 2005, six permanently re-flooded sites were selected to study the restoration effect on Marsh Arabs, including the Huweizah Marsh (4% of settlements built after 2003), Eastern Hammar Marsh, (47%), Al Aweh Marsh (32%), Central Marsh (18%), Abu Zirig Marsh (7 %), and Western Hammar Marsh (14%). Climate change, repeated droughts, upstream water diversions and dam building activities continue to threaten these important wetlands. To preserve the marsh ecosystems and culture, Iraq’s government is implementing water conservation and restoration actions such as water regime modification and regulation of outlets in selected marshes.

**Sustainable reef design to optimize habitat restoration**

**Haseline, Mara**

*Eugene Lang College, USA*

Effective habitat restoration requires innovative reef designs that optimize biological processes, alternative reef building methods that do not use plastic or concrete, and use renewable energy from solar, tidal, wind and wave power as energy sources. Special attention must be paid to maximize flow of water and light through the reef, providing reef inhabitants the maximum amounts of oxygen, food, and nutrients, while flushing away wastes. Reefs should be designed so their shape increases growth of structure-builders like coral and oysters, while providing habitat for other reef organisms to hide and spawn, increasing biodiversity. This is especially important if the reef is to be used for sustainable fish farming. Specially sized and shaped nooks and crannies can be designed into artificial reefs so that particular species will live there and can be successfully farmed without the use of nets, antibiotics, growth hormones, or external food additions. Special attention must also be paid to surrounding waters and benthic habitat so there is as little impact as possible and light as well as water can pass through the structure. Designs of structures presented in this paper utilize the concept of “Biomimicry”, adapting their blueprints from Mother Nature’s design strategies, which have evolved over billions of years, on a wide variety of scales from microscopic to megascopic. Designs based on these principles should allow restoration of degraded habitat that is much more biologically diverse and productive than conventional artificial reef structures.

**Reference conditions and restoration goals at the Rocky Mountain Arsenal, Colorado (USA)**

**Havlick, David; Marion Hourdequin**

*University of Colorado, USA*

Identifying an appropriate reference condition has long posed a challenge in ecological restoration. The task becomes even more difficult in settings with diverse land use histories. At the Rocky Mountain Arsenal National Wildlife Refuge near Denver, Colorado, a former chemical weapons manufacturing facility is being restored into one of the largest urban wildlife refuges in the U.S. Army contractors and wildlife managers are working to isolate contaminants and restore bison and native shortgrass prairie, but past activities at the site call for a deeper
consideration of reference conditions. This paper presents data from a 2010 visitor survey conducted on-site, as well as interviews with regulators, land managers, and local citizen groups, to examine concepts of historical fidelity and naturalness at this site. Our results indicate that certain constituencies connect deeply to the site’s prior military, agricultural, or homesteading activities, but most visitors favor a traditional concept of restoration that returns to a pristine reference condition, in this case shortgrass prairie or Native American settlements. Visitors considered public safety the least important restoration goal at the site, despite four decades of operation as a chemical weapons plant and a record of severe contamination. Our research highlights how information and normative values can move both ways at restoration sites, with restoration activities not just being shaped by management goals or public expectations, but the restoration work itself contributing to a set of values that inform visitors and affirm how a landscape ought to exist.

**Fire in conservation areas: Impact on dead wood creation and saprophylic beetles**

*Hekkala, Anne-Maarit; Anne Tolvanen*

Finnish Forest Research Institute

The largest group of red-listed species in Finland are species living principally in forest habitats. The main reason for the degradation of biodiversity is forest management, which has caused fragmentation of forest into small patches, led to the lack of coarse woody debris, and maintains efficient fire control. As a consequence, species dependent on dead or burned wood have reduced dramatically. Restoration of forests simulates natural disturbances and aims at bringing back some essential components typical to natural forests. The Finnish Forest Research Institute has been studying the effects of restoration on forest-dwelling species assemblages and dead wood creation in 2005-2007. The purpose of this study is to investigate how burning improves the habitats of dead-wood dependent beetles and how these species respond to restoration practices. The study design includes 18 pine-dominated study sites in eastern Finland with two burn treatments and untreated control. Prescribed burning was conducted in 2006. Beetles were collected with window traps in 2005-2007. The number of beetle individuals and species increased in both years after burning. Species numbers were not significantly different among the burning treatments, but increased amount of dead wood had a clear impact on the species assemblages. Endangered beetle species benefit by controlled burning, although some species might disappear following fire application. In the vicinity of adequate source areas, suitable habitats for some endangered beetle species can be maintained with prescribed burnings, where the trees are left on the burned sites after fire.

**Natural resource damage assessment restorations and the mc-252 Deepwater Horizon Oil Spill**

*Helm, Roger*

US Fish and Wildlife Service

In the U.S., a few Federal Departments, all states, and many tribes (collectively the Trustees) are authorized under the Oil Pollution and Clean Water Acts to pursue natural resource damages (NRD) to restore the environment following the release of oil. The U.S. Fish and Wildlife Service (Service) investigates oil releases to determine the extent and magnitude of the injury to, among other natural resources, federally listed species, migratory birds, certain fish, and Refuge lands. Working with other Trustees whose natural resources also may have been impacted, we translate the injury to natural resources into a legal-based damage claim for restoration. The Service is the primary bureau within the Department of the Interior involved in NRD cases and nationally we lead over 500 cases for the Department. Along with our Co-trustees, the Service has obtained about $1,000,000,000 in restoration funding and spent well in excess of $100,000,000 for restoration and land acquisition to restore fish, wildlife, and habitats impacted by oil spills or hazardous wastes. For example, in 2008 the Service and our Co-Trustees restored or protected >12,000 wetland acres and 850 stream miles, restored seabird colonies, and increased human access to natural areas. I will present several examples of restoration projects from past oil spill NRD claims and discuss the Department’s NRD investigations following the MC-252 Deepwater Horizon oil spill. I also will review some of the numerous restoration options the Trustees have or are considering implementing with the early restoration funding provided by BP.

**Tropical stream macroinvertebrate community responses to changes in land-use: Is restoration more advantageous at the local or landscape scale?**

*Helson, Julie; D. Dudley Williams*

University of Toronto, Canada
Tropical stream macroinvertebrate communities are still understudied compared with their temperate counterparts. This, together with increased frequency and intensity of human-related disturbances in the tropics, urgently requires documentation of lotic biodiversity and community functioning in the relative absence of human impacts, as well as the subsequent changes that occur in the presence of humans. This two year study, of fifteen streams in the Republic of Panama, examines how freshwater macroinvertebrate community structure changes along a pristine-rural-urban landscape gradient and whether in-stream characteristics (e.g., water quality and in-stream habitat) or landscape features (e.g., riparian vegetation and land-use) better predict community patterns. Along the land-use gradient, diversity (p<0.001) and richness (p<0.001; seasonal interaction) decreased significantly; whereas, abundance (p<0.001) increased significantly. Seasonal differences occurred in both the total amount of macroinvertebrate community variation explained by environmental variables (Dry: 45.2%; Wet: 33.6%) and the partitioning of variation, with in-stream and landscape characteristics explaining equal variation in the dry season and landscape explaining slightly more than in-stream in the wet season. Community variation was predominately explained by land-use (17.9%) and water quality (13.2%) in the dry season, in contrast to riparian (11.7%) and in-stream habitat (7.8%) in the wet season. Because communities respond to different spatial scales at various times during the year numerous factors need to be considered when devising the most effective restoration strategies and efficient management decisions.

Sierra sur de Oaxaca, comunidades de usos y costumbres: Entre la tradición y el desarrollo (cultura, política y ambiente)

Hernández García, Miguel Ángel; Mauricio Sosa Montes, Venancio Pérez Sánchez, Érica Yesenia Reyes Silva Baldomero Díaz Díaz

Universidad de la Sierra Sur, México

Desde diversas perspectivas y muy variados enfoques se ha pretendido entronizar, en el estado de Oaxaca, esa forma de organización comunitaria reconocida como “usos y costumbres”. ¿Qué significado cultural, político, estructural, organizativo tiene, para las mismas comunidades, en estos tiempos de profundos cambios ecosociales y desde una perspectiva de desarrollo, tal forma de estructura y organización comunitaria? Responder a esta interrogante ha requerido de un arduo, abrupto y a veces enconado proceso de búsqueda de hechos, acciones y actores, dispuestos a establecer un diálogo que perturba y vuelve inasibles certidumbres, saberes, horizontes… Es claro que la única certeza que el hombre tiene acerca de sus construcciones sociales, sus instituciones, es su predestinación al cambio, a la extinción. Sin embargo, su pervivencia tempo-espacial descansa en la relevancia como vía de legitimación de un orden social determinado. El histórico proceso de modernización, actualmente caracterizado por una fase de globalización y políticas de ajuste neoliberal, ha mostrado que aquellas instituciones fundadas en usos y costumbres, que fueran funcionales para las estructuras culturales, organizativas, productivas y reproductivas de muchas comunidades indígenas y campesinas, han perdido su relevancia y significación pues ya no son aquellas instancias de diálogo constructor y reconstructor de identidades y saberes; sus poblaciones se encuentran sumidas en constantes procesos de pérdida de recursos naturales, pauperización, marginaición, migración, desidentidad, de mera lucha por la sobrevivencia en la que las incertidumbres son el horizonte cuya perspectiva se oscurece con la negritud de la noche para renovarse interminablemente al día siguiente…

Restoring productivity in Nahuatl communities through traditional management of Spondias purpurea stakes

Hernández Muciño, Diego; Eliane Cecon, Eleonora Flores Ramirez

UNAM, Mexico

Anthropogenic disturbances in seasonally tropical dry forests have induced dramatic loss of forest products and ecosystem services. Therefore, it is important to identify social and biological tools to efficiently restore these ecosystems. In this study, we investigated traditional knowledge of stake management of the native and widely used species Spondias purpurea in a Nahuatl community in Morelos. We then experimentally evaluated the efficiency of distinct methods of vegetative reproduction and establishment of this species, both in the greenhouse and the field. Through interviews with local farmers we learned that the main use of this species is fruit production and living fences. Traditional management consists of cutting 2m-tall stakes without leaves between February and March and planting them in May (the driest month). We tested the growth and survival of stakes of S. purpurea of four different sizes (1 or 2m of height and greater or less than 30cm diameter) in a degraded area. After four months, 1m and 2m stakes of greater than 30cm diameter had the highest survival rate (47% and 43%, respectively). The thickest stakes had the highest RGR (0.17cm. cm-1.month^-1), and 2m stakes had the highest number of branches (14 branches). Our main conclusions are: information obtained in the interviews was essential for experimental design, however
some important information was not obtained, demonstrating the importance of improving the focus and specificity of interview questions. Additionally, though small, thin stakes are easier to manage, their use is not biologically recommended. Finally, it is necessary to involve all community members in order to guarantee the success of the experiment.

**Evaluación del papel potencial de Leucaena macrophylla para proyectos de restauración productiva**

**Hernández Muñoz, Diego**
UNAM, Mexico

Atualmente enfrentamos um panorama de fragmentación de hábitat, redução de biodiversidade y pérdida de servicios ambientales que contribuyen a la marginación en áreas rurales. La implementación de herramientas agroecológicas se han propuesto como estrategias viables de restauración productiva. En una región pobre del estado de Guerrero instalamos un sistema de cultivo en calles incorporando una leguminosa nativa de la selva baja al cultivo tradicional de maíz. Evaluaremos el efecto del sistema durante cuatro años a través de la disponibilidad de nutrientes del suelo, las condiciones microclimáticas y la productividad. Además, probaremos la efectividad de Azospirillum sp. como biofertilizante. Valoraremos si la leguminosa posee características propias para su uso en sistemas agroforestales, basados en la calidad del mantillo, de la madera y del forraje. Los resultados iniciales (primeros 5 meses) muestran un 89% de supervivencia de L. macrophylla, presentando la mayor mortalidad en el primer mes. Además, la leguminosa duplicó su diámetro basal y su altura, y aumentó en promedio 26 veces el área inicial de la copa. La producción de maíz fue significativamente mayor en el monocultivo con fertilizante químico comparada con el cultivo mixto y el monocultivo con biofertilizante. El Índice de Equivalencia de Área (Land Equivalent Ratio), sin embargo, indica de 1.5 a 2 veces mayor productividad de maíz y madera en los cultivos mixtos que en los monocultivos.

**La restauración ecológica y la ética ambiental, retos para el presente milenio**

**Herrera, Francisco; Yahaira Salazar, Maribel Ramos**
Instituto Venezolano de Investigaciones Científicas

En las últimas décadas, y de manera creciente, la humanidad ha tomado conciencia del marcado deterioro que están sufriendo los ecosistemas del planeta como consecuencia de las actividades extractivas que sustentan el modelo de desarrollo imperante. Entre las consecuencias destaca la progresiva acumulación de dióxido de carbono en la atmósfera (49 GtCO₂-eq/año en 2004) y su relación con el cambio climático. Prácticas como la reforestación, la aforesatión y la recuperación de ecosistemas han emergido como mecanismos de mitigación del desbalance de CO₂ en la biosfera, sumadas a otras propuestas de captura y almacen de carbono. Informes del Grupo Intergubernamental de Expertos sobre el Cambio Climático sugieren que las tasas de mitigación de carbono con estas prácticas, podrían contrarrestar solo las emisiones por deforestación (17,3% de las emisiones globales). Existen múltiples factores que generan incertidumbre con relación a las proyecciones de estas políticas, principalmente por las tensiones existentes entre el aprovechamiento de los recursos y la mitigación de sus consecuencias; se suma, el supuesto de la modernidad que garantiza soluciones tecnológicas a las crisis tecnológicas; este supuesto impide un cuestionamiento real de los fundamentos que generan la crisis. La restauración ecológica, y en especial los programas de aforesatión/reforestación, deben abordar esta realidad desde una dimensión crítica para poder dar respuesta a los retos del milenio.

**Ecological restoration of mangroves in karstic regions: The Yucatan Peninsula case**

**Herrera Silveira, Jorge Alfredo; Arturo Zaldivar Jiménez, Claudia Teutli Hernández, Rosela Pérez Ceballos, Juan P. Caamal-Sosa, Teresa Andueza Briceño, Tomas Zaldivar Jiménez, Ricardo Ortegañ, Adriana Hernández, Mario Méndez, Gabriel Benavides, Jose Luis Andrade, Isaac Castillo**
CINVESTAV-IPN, Unidad Mérida, México

Yucatán’s mangroves have been objected to various kinds of impacts, highlighting the land use changes for urban and tourist developments, where highways and ports have been the major causes of loss coverage. That is why many attempts to recover mangrove have been carried out since the 90’s, however, these were usually done without a sound technical and ecological basis. Therefore, the “Grupo Interdisciplinario Manglares Península de Yucatan” (GIMPEY) is developing a program of ecological restoration in 9 locations in the state of Yucatan (SE, Mexico). This program was developed in collaboration with Federal agencies (SEMARNAT Delegation Yucatan) research centers, (CINVESTAV-IPN, U. Mérida and CICY), and an NGO (Ducks Unlimted de Mexico A.C.). This program is
based on the following steps: 1) Forensic Ecology (determination of the causes of mangrove death; 2) characterization of hydrological, sediment and vegetation of the site to be restored; 3) proposal and implementation of specific actions as: hydrological rehabilitation, dredging or construction of wells, removal of sediment, dispersal centers, construction and maintenance of flow channels; 4) establishment and monitoring of success indicators at different temporal scales, 5) binding and socialization of restoration project to the local groups. In all locations the following recovery symptoms have been observed: salinity interstitial reduction, hydroperiod restored, seedling establishment and growth, recovery of vegetation cover without reforestation. The success of social and environmental benefits of this program is serving as a model to adapt in other states of the Gulf of Mexico.

The power of ecological restoration to create meaningful social change

Higgs, Eric
University of Victoria, Canada

Ecological restoration has shown in many ways that it can regenerate damaged and degraded ecosystems. Less often noted and studied is the effect restoration activities have in creating social change, and how this will be increasingly important to understand in the face of rapid environmental, ecological and cultural shifts. There are five broad categories for understanding the social value of restoration. First, it creates social cohesion by bringing people together. This is especially important in urban areas where access both to natural processes and stable community structures can be elusive. Second, people are brought into a profound relationship with ecosystem process through their participation. Such hands-on engagement is critical for stimulating a deeper understanding of the value of nature in itself and to people, and it is especially important for children. Third, ecological restoration has inherent democratic potential through participation and community engagement. Fourth, all acts of restoration also provide ecosystems services, many of which are directly useful to people. Finally, as a combination of the previous four categories, restoration benefits human communities-at risk, those that struggle for identity, or sustenance or both.

The importance of international principles and guidelines for ecological restoration in protected areas

Higgs, Eric
University of Victoria, Canada

Experience in Canadian protected areas is that clear principles and guidelines offer at least two important benefits: 1. Practical advice for implementing restoration initiatives; 2. Network-wide support for restoration. Restoration projects are varied, almost as much as the ecosystems that are supported by such practices. The importance of principles and guidelines is finding common threads that cut across ecosystems, learning from successes and failures elsewhere, and supporting innovation in restoration science and practice.

Endangered species legislation as a stimulus for habitat restoration

Hilditch, Tom
Savanta Inc., Canada

Southern Ontario is one of the most developed and fastest growing areas in Canada. The urban areas around Ontario's capital city, Toronto, are home to about 8 million people with another 3.5 million expected to inhabit the area by 2031. In the face of this ongoing growth, Ontario has developed and implemented a series of legislative and policy measures to conserve open spaces and to encourage the restoration of disturbed areas (e.g., The Greenbelt Plan, Places to Grow, etc.). One of those measures was the new Endangered Species Act, 2007, targeted towards the conservation and recovery of about 200 species at risk. Rather than a sole reliance upon enforcement and litigation, stewardship plays a prominent role in the legislation along with provisions that allow for consideration of potential impacts on species at risk and/or their habitats, subject to the satisfactory demonstration of an “Overall Benefit” to the species. That “Overall Benefit” test is stimulating significant restoration work in favour of those species. This paper summarizes this legislation and its effectiveness in encouraging habitat restoration for species at risk. Examples related to various industrial sectors are presented along with specific reference to: Best Practice Guidelines for Species at Risk Rehabilitation in Aggregate Projects. This paper also discusses differences between various jurisdictions related to Species at Risk conservation and habitat restoration.
REDD+ and tropical forest restoration: Opportunities and concerns

Holl, Karen
University of California, Santa Cruz

Clearing of tropical forests results in ~15% of carbon emissions globally. As a result, reducing emissions from deforestation and forest degradation (REDD) is part of climate mitigation discussions at the regional, national, and global scale, and tropical forest restoration is increasingly included as part of these discussions. Payments for carbon stocks in restored forests could provide much-needed funds for forest restoration and provide an opportunity to simultaneously enhance the biodiversity value of degraded tropical lands. But, using tropical forest restoration to offset carbon emissions raises a number of concerns. In this talk I draw on my own and others' research to address three specific issues. First, numerous studies on both active and passive forest restoration show that rates of forest recovery are highly variable even within the same region, meaning that it is difficult to predict the rate at which carbon stocks will recover. Second, it is unclear whether the amount of the payments will be sufficient to offset initial restoration costs and ongoing management. Most past studies show that payments for environmental services have a relatively small effect on changes in forest cover. Third, past research indicates that there are often tradeoffs in maximizing carbon stocks and biodiversity in the same site. The first priority for REDD payments should be to conserve relatively intact forest. Paying land owners to restore forest may be an appropriate strategy, however, in areas that are already heavily deforested if several concerns are addressed.

Restoring globally endangered dry tropical forests in Ecuador: The experience of the Pro-Forest Foundation

Horstman, Eric; John Ayon
Pro-Forest Foundation, Ecuador

The Pro-Forest Foundation, an Ecuadorian non-profit conservation organization has worked for eighteen years to restore critically endangered Ecuadorian Dry Tropical Forest in the Cerro Blanco Protected Forest. Located on the outskirts of the city of Guayaquil Ecuador, the 6,078 hectare Cerro Blanco reserve includes a mosaic of vegetation, from abandoned pasture land dominated by *Panicum maximum*, secondary scrub vegetation and near climax forest. Beginning in 1993, work began to restore dry tropical forest, through the planting of a total of more than 500,000 trees of 35 native species in enrichment parcels in and around existing patches of mainly secondary forest. The restoration program, which had depended on limited resources, received a major boost in 2007 with the signing of a tree planting agreement through the World Land Trust to support tree planting and maintenance of planted areas. Overcoming obstacles including illegal land “invasions” by land traffickers and forest fires, the overall survival rate of the planted trees is between 50 and 65%. Restored areas provide critical habitat for globally threatened and endangered species, including Great Green Macaw (*Ara ambiguus guayaquilensis*) and Jaguar (*Panthera onca*). Community park wardens help Pro-Forest Foundation forest guards to protect planted trees and work in surrounding communities to create awareness of the importance of tree planting. Based on our experience in Cerro Blanco, other organizations, including a local water company and a cement company, are contracting the Pro-Forest Foundation to restore watersheds and rehabilitate abandoned mine quarries.

Herramientas participativas de ayuda a la planeación de políticas regionales de restauración forestal

Huerta Silva, Margarita Haydee; Manuel Roberto Parra-Vázquez
Universidad de Alcalá, Spain

Ante el problema del deterioro y la perdida de bosques, y a la falta de políticas públicas de restauración integrales donde no solo se persiga reintroducir árboles sino también aportar beneficios a las comunidades emprendedoras, el presente estudio propone una metodología de planeación basada en el diagnóstico participativo de los medios de vida de las comunidades y en el estudio ecológico de sus áreas boscosas, para realizar una priorización de comunidades donde se podría emprender un plan de restauración forestal con mayores probabilidades de éxito. En un segundo momento se avanza con los actores locales en la construcción de una estrategia de acción basada en el conocimiento de sus modos de vida, sus activos, necesidades e intereses locales, que incentiven acciones de conservación, restauración y manejo sustentable de sus recursos naturales a corto, mediano y largo plazo. Las herramientas de planeación utilizadas cumplen con las siguientes características: incluyentes, rápidas, replicables, comparables, integrales, dinámicas y económicas, que se abordan bajo un enfoque complejo (holístico-sistémico). Se presentan los resultados obtenidos en diferentes comunidades del Estado de Chiapas, México. Que dan cuenta de la relevancia de
How well do molecular markers predict outbreeding depression? A test in the Stylidiacea

Hufford, Kristina; Siegy Krouss, Erik Veneklaas, Hans Lambers
University of Wyoming, USA

Restoration practitioners commonly select seeds of local origin or provenance for site revegetation. A principal challenge in restoration seed sourcing continues to be the accurate prediction of the distance within which propagules remain local. One method to determine local provenance seed transfer zones is their delineation based on estimates of population genetic differentiation using molecular markers. But how well do molecular marker data reflect not only the adaptive differentiation among populations, but also the scale beyond which outbreeding depression may impact on restoration success? Following hand-pollination manipulations, we have detected evidence for outbreeding depression in germination and survival of first-generation hybrids in the Australian triggerplant species, Stylidium hispidum. We then estimated population genetic differentiation along a north-south transect of the species range, and compared marker predictions for local provenance zones with fitness estimates of intraspecific hybrids from varied crossing distances. Using AFLP markers, we calculated population genetic differentiation for 16 populations of S. hispidum in Southwest Western Australia. Our data suggest some consistency of population genetic differentiation with hybrid fitness of short- and long-distance crosses. Results are discussed in light of S. hispidum mating system and life history, with recommendations for restoration seed sourcing.

Plantations aren’t just for timber anymore: Multiple benefits likely from diverse carbon plantations

Hulvey, Kristin B.; Richard J. Hobbs, Rachel J. Standish, David B. Lindenmayer, Lori Lach, Michael P. Perring
University of Western Australia

Increasingly plantations established on degraded landscapes are being used to sequester carbon and produce carbon offsets. The traditional role of plantations for timber production, however, means best-practice methods for plantation carbon sequestration and storage are underdeveloped. We examined the assumption implicit in current practice that monospecific or low-diversity tree plantings maximize carbon sequestration. This assumption contradicts two decades of biodiversity-ecosystem functioning research that largely finds increasing diversity has a positive, saturating relationship with several ecosystem functions. We found experimental and theoretical support for diversity’s positive influence on short- and longer-term carbon storage. First, published tree productivity data of monocultures vs mixtures indicates that tree diversity may increase plantation carbon sequestration. Additionally, the extension of established biodiversity-ecosystem functioning theory to carbon storage in plantations indicates that carbon-pool formation and stability might be favored by increased diversity at longer time-scales. Theory also indicates that high-diversity plantations are more likely to provide a portfolio of ecosystem services that can potentially generate payments in addition to those for carbon offsets. Our results can inform the creation of both carbon policy and landscape restoration goals by highlighting the role of tree diversity in carbon plantations.

The Maunalua Bay Reef Restoration Project: Lessons from large-scale removal of invasive alien algae

Hum, Kim; Eric Conklin, Manuel Mejia, Alyssa Miller, Dwayne Minton, Luke Estes, David Ziemann
The Nature Conservancy, USA

The invasive alien algae, Avrainvillea amadelpha, has fundamentally altered the extensive, shallow reef flats of Maunalua Bay, transforming a diverse mosaic of native algal and seagrass communities into a sediment-laden monoculture of alien algae. Successful, small-scale grassroots efforts to remove this alien alga led to NOAA awarding The Nature Conservancy “stimulus” funding from the American Recovery and Reinvestment Act of 2009 to remove some of the densest stands of this alga as a first, critical step towards restoration of the native near shore marine community. The project took best advantage of the complementary expertise and experience of federal agencies, University researchers, large NGOs, local businesses, and community groups in a collaborative approach that resulted in 27 acres cleared and nearly three million pounds of invasive algae removed, all of which went to local farmers and green waste processors for soil amendments and composting. One year after clearing, plots are beginning to show partial recovery of native species with no return of invasive algae. Scientists developed a comprehensive research program to ensure that the project was effective and contributed valuable information on how best to proceed with restoration efforts in the bay and elsewhere. The attention brought to the area by the project and the capacity building it enabled for local community groups has energized complementary watershed restoration
and marine management initiatives in the region, including stream restoration, sediment reduction, and sustainable fisheries management.

‘The Rehabilitation Conundrum’ – ecological processes vs. rehabilitation measures and landscape aesthetics in the Namib Naukluft Park, Namibia
Humphrey, Glynis
Namib Hydrosave, Namibia

The unique Namib Naukluft Park (NNP) landscape in the Namib Desert is characterised by continuous aridity, high magnitude winds (Eckardt et al. 2001), regular fog-belts emanating from the north-south Benguela current, and unpredictable rainfall (Burke, 2001). The presence of economically viable mineral deposits and subsequent exploration activities within the NNP has recently resulted in a focus on practical and appropriate rehabilitation measures. Following the application of these measures, some pertinent questions have been raised. Firstly, given the nature of the Namib environment and associated unknown restoration potential of different soil desert substrates, how does one establish a principle of best practice which would include when to halt rehabilitation measures and leave the system to recover through natural ecological processes? Secondly, how is this related in scale to landscape aesthetic requirements in a National Park? There is a need to identify critical aspects of ecological processes in order to provide indicators of successful rehabilitation measures in the Namib Desert (e.g. applied local rehabilitation measures vs. natural restoration processes). It is essential that an ecological baseline be linked to the assessment of the effectiveness of the rehabilitation measures vs. the natural ecological processes (spatial and temporal) at play. The “Rehabilitation Conundrum” will be presented with examples from projects in the Namib Desert in Namibia.

Biorock technology increases coral growth and fish assemblages
Ilham, Ilham; Rosihan Anwar, Syarif Syamsuddin, Thri Heni Utami Radiman, Heri Triyono, R. Ahmad Sue, Delphine Robbe, Thomas J. Goreau
University Indonesia

This study investigated Biorock restoration effects on growth rates of the table coral, Acropora valenciennesi, and the staghorn coral, Acroporaformosa, in Gili Trawangan, Lombok, Indonesia. The first phase had three treatments: electrified, conventionally transplanted, and natural colonies of A. valenciennesi as controls. Growth rate of biorock-treated coral colonies was significantly higher than the other two treatments (p<0.05). Growth rate of Biorock corals averaged 0.31 cm per week, around 7.5 times faster than natural colonies and 4 times faster than conventionally transplanted corals. In the second phase underwater visual censuses (UVC) showed that fish species richness and abundance were significantly higher around Biorock coral structures. Fish abundance inside Biorock coral structures was 6 times higher than that outside. Diversity index, Evenness index and Simpson’s dominance index were 2.15, 0.63, and 0.18 respectively. In the third phase, fragments of A. formosa were transplanted to electrified reefs at 3 meter, 5 meter, and 8 meter depth. Electrified corals at shallow depth (3 m) grew more rapidly than deeper ones. Both vertical and horizontal growth rates of electrified A. formosa were statistically 3 to 4 times higher than naturally growing corals. These findings demonstrate that application of Biorock technology in Indonesian waters has potential for coral reef rehabilitation, particularly in shallow waters. Biorock reef structures may serve as models for future sustainable restoration of coral reef habitat specifically designed to restore fish communities, even in areas where natural reefs have been badly damaged.
cada comunidad tiene características fisicobióticas y sociales y una historia diferente y tiene proyectos propios, por lo tanto no hay recetas, con cada una habrá un proceso único. Habrá mayor probabilidad de éxito si hay confluencia entre los proyectos de los habitantes de la comunidad y del grupo técnico. Partir de una perspectiva de mediano o largo plazo, establecer relaciones de respeto, confianza, igualdad y diálogo de conocimientos (campesino y científico), reconocer y fortalecer las instituciones comunitarias así como contar con financiamiento estable han resultado elementos fundamentales para impulsar procesos de manejo adaptativo de los recursos naturales. La ausencia de conflictos de alta intensidad, tanto dentro de la comunidad como en la región también es factor determinante.

**Formulación de estrategias para la restauración ecológica de los páramos Andinos trasformados por actividades de ganadería: El caso en el Parque Nacional natural Chingaza, Colombia**

Insuasty Torres, Jennyfer; Camilo de los Ángeles Cárdenas, Oscar Rojas-Zamora, Orlando Vargas Ríos, Pilar Angélica Gómez-Ruiz.

Universidad Nacional de Colombia

El páramo es un ecosistema presente en el norte de los Andes y algunas montañas de Centroamérica y África, tiene características únicas como clima con alta variación diaria, principalmente en la temperatura, y especies adaptadas a distintas condiciones de estrés. A pesar de su importancia por su biodiversidad y servicios ambientales, como la regulación del ciclo hidrológico, los páramos andinos tienen una larga historia de disturbio. En Colombia, la ampliación de la frontera agrícola y la ganadería extensiva, junto con actividades asociadas como la quema de la cubierta vegetal, afectan la composición y estructura de las comunidades de plantas, las propiedades del suelo y favorecen el establecimiento de pastos exóticos invasores. Con el fin de establecer estrategias de restauración ecológica exitosas en áreas de páramo pastoreadas, se examinaron los siguientes aspectos: 1) la reubicación de individuos de *Espeletia grandiflora* y especies de pajonal, principalmente *Calama grostis effusa*, 2) el manejo del suelo y 3) la siembra de *Lupinus bogotensis* como facilitadora del establecimiento de especies vegetales nativas. Después de dos años de seguimiento, los resultados más importantes fueron 1- la formación de parches gracias a la reubicación de individuos de *E. grandiflora* y macollas de pajonal, de los cuales sobreviven hasta más del 80%, y 2- la caracterización de la colonización vegetal luego de la remoción de pastos invasores y la descompactación del suelo. Se plantea una segunda fase de investigación para seleccionar, reubicar y propagar otras especies nativas que contribuyan en la formulación de estrategias de restauración ecológica.

**Restoring the pine-grassland forest in the Southeastern U.S.: Fire, trees and ground cover**

Jack, Steven

J.W. Jones Ecological Research Center, USA

The longleaf pine (*Pinus palustris* Mill.) forest was once the dominant upland forest type on the southeastern Coastal Plain in the U.S. but now is rare, occupying only 3-5% of its historic range due to changes in land use and a focus on short-rotation forestry practices. Fire is essential for perpetuating the longleaf forest and helps maintain the open midstory condition and grass-dominated groundcover. Natural longleaf forests with frequent fire typically have high diversities of both plant and animal species, including many endemics that are threatened or endangered. Because of their high conservation value there has been much recent interest in restoring the longleaf pine-grassland forest type. Restoration activities are implemented along a continuum of starting conditions from sites without existing forest cover (e.g., agricultural fields) to conversion of industrial pine plantations. Whatever the starting condition there are three key elements to consider: establishing longleaf pine as the dominant canopy species, development of a diverse grass-dominated ground cover that also provides fuel, and the use of fire to maintain structure and diversity. These three elements are interdependent, and silvicultural manipulations for restoration objectives must be evaluated in light of their effect on these integrated elements. This presentation will provide an overview of some recent holistic approaches to restore the longleaf pine-grassland ecosystem, including research results that form the basis for these approaches, and discuss the role of silviculture in implementing restoration activities.

**Ratchets and rivers of time: Ecological restoration’s historical dilemma**

Jackson, Stephen

University of Wyoming, USA

Historical ecology and paleoecology are valuable tools for restoration ecologists. They provide empirical baselines for restoration, yielding information on how much damage or degradation has occurred. And by offering glimpses of the natural state of ecosystems before disturbance, they provide seemingly straightforward, objective targets for
restoration. Such targets, however, may be problematic, for two reasons. First, the environment has changed, usually irreversibly since inception of disturbance, so historical targets may no longer be sustainable. In some cases, environmental change is a product of the human disturbances themselves, but climate has changed substantially across the globe in the past few centuries, and will change more rapidly in the immediate future under greenhouse-gas and land-use feedback forcing. Second, ecological processes are laden with contingencies, and so ecological realizations at any given time incorporate historical legacies of previous events and regimes. Thus, a particular historical target may have been only one realization among several potential alternative states, depending upon the antecedent conditions and events. Specific historical targets may be somewhat arbitrary from this perspective. Historical ecology’s role in restoration ecology must expand beyond simply serving up restoration targets, to include identifying the sensitivity, resilience, and adaptability of species and ecosystems to different kinds of environmental change, and understanding the properties and processes underlying responses to past environmental changes.

Demographic and soil processes driving recruitment limitations in arid land restoration
James, Jeremy; Tony Svejcar, Matt Rinella
US Department of Agriculture

Seedling recruitment is a key process driving vegetation change and restoration outcomes. Recruitment, however, in arid systems is episodic and many management efforts to accelerate recruitment often fail. The research presented here examines the key demographic and soil processes that may influence recruitment patterns in the Great Basin of the United States. In experimentally disturbed plots, in each of three years, we estimated demographic stage transition probabilities for three species commonly used in sage steppe restoration. We also made similar measurements on seed sown by land managers following four major fires. Across years and sites, the transition between a germinated seed to an emerged seedling was the major recruitment bottleneck. Germination probability across species, years and sites was high, averaging 0.72. However, over 90% germinated failed to emerge. Given the large loss of individuals early in seedling development, variation in survival probabilities for later transitions had little impact on recruitment. Ecological processes occurring later in seedling development, such as spring and summer drought are unlikely to influence restoration outcomes. Processes occurring during emergence, on the other hand, such as freezing and thawing of the seedbed, development of physical soil crusts and pathogen attack on seedlings before they emerge may be large drivers of restoration failures. Managing processes inhibiting emergence and developing seed mixes with higher emergence probabilities may greatly improve restoration outcomes in the sage steppe and similar cold desert systems.

Disturbance regimes and restoration of mountain forest ecosystems in Western Mexico
Jardel Peláez, Enrique; Oscar E. Balcázar Medina, Jorge E. Morfín Rios, Faviola Castillo Navarro, Paulina Llamas Casillas, Socorro Vargas Jaramillo, Juan Manuel Rodríguez Gómez, Ramón Cuevas Guzmán, Ernesto Álvarado, Diego Pérez Salicrup
Universidad de Guadalajara, Mexico

Mexican forests have a long history of human influence, even in protected areas recognized for their rich biodiversity and natural values. This influence has been part of the pattern, process, and dynamic of forest ecosystems and understanding the relationship between natural conditions such as climate, landform and soils, vegetation and the role of both natural and anthropogenic disturbance is a key issue for designing sound ecosystem management practices for conservation, sustainable use and restoration. In the Sierra de Manantlán Biosphere Reserve in Western México, we have made long-term ecological studies about the history of use and management of forest resources and historical disturbance regimes. The study area's forests were logged intensively for timber production (1940-1980) and most of the pine-oak and oak forests have been subjected to the influence of wildfire and cattle grazing. Because of this, ecological restoration has been considered an important component of management for biodiversity conservation and watershed protection in the reserve. Appropriate restoration management involves a clear definition of what are degraded or unnatural conditions and understanding of the role of disturbance regimes and the historical range of variation in forest ecosystems. We studied the influence of wildfire, grazing and logging history in the composition, structure and stand dynamics of pine-oak forests and cloud forests in environmental and disturbance gradients, chronosequences and permanent plots. A model for the characterization of potential and historical fire regimes is proposed for the Sierra de Manantlán region and its implications for conservation and ecological restoration is discussed.
Integrating landowner opinion with ecological data to help revegetate agricultural landscapes and improve biodiversity

Jellinek, Sacha; Kirsten Parris, Don Driscoll, Brendan Wintle
University of Melbourne, Australia

Biodiversity loss is occurring globally, mainly as a result of habitat loss caused by land clearing and fragmentation of unprotected land. Many researchers advocate for the revegetation and restoration of privately owned land because many valuable habitats remain in these areas, and the protection of state-owned land will be inadequate to stop biodiversity loss. Our project assessed the benefits of replanting linear strips and enlarging existing remnant areas for reptiles and invertebrates (Coleoptera) in agricultural areas of south-eastern Australia. We also assessed whether local landowners participated in revegetation projects and their attitudes to revegetated and remnant vegetation. Reptile and beetle species richness and abundance did not alter substantially between revegetated, remnant and cleared habitats; although individual species showed a preference for remnant linear strips, and ground-layer attributes were a strong predictor of reptile and beetle community composition. Although many landowners had undertaken revegetation on their properties in the form of trees and shrubs in linear strips, few managed revegetated or remnant areas for conservation purposes. Overall, revegetated areas lacked native grasses and other important attributes of the ground layer, while remnant patches were poorly managed, resulting in an impoverished fauna with rarer species restricted to remnant linear strips.

Barreras para el establecimiento de especies leñosas del Arbustal Alto de Páramo en áreas en sucesión secundaria

Jiménez Restrepo, Diana Isabel; Luis Daniel Llambi Cartaya
Universidad de los Andes, Colombia

El ecosistema de Arbustal Alto en el Páramo de Gavidia está entre los 3200 y 3600 msnm y presenta la mayor riqueza de especies en la zona, aunque su cobertura se ha reducido a 182 hectáreas en la microcuenca por actividades agrícolas y extracción de leña y carbón. Las áreas en regeneración recuperan la cobertura vegetal durante el tiempo, pero es dominada por especies del Rosetal Arbustal, mientras la vegetación original del Arbustal no coloniza las áreas en sucesión evidenciando barreras en el establecimiento. Al evaluar la estructura demográfica de algunas leñosas, hubo densidades mayores dentro del arbustal, medias en el borde y muy bajas en el barbecho. Las condiciones ambientales óptimas para su crecimiento son las bajas radiaciones solares y suelos con temperaturas bajas y humedades altas, siendo los bordes y doseles del barbecho, buenos refugios en la sucesión. En las vecindades inmediatas de B. discolor, mejor colonizadora, los conspecíficos se encontraron agregados en los estadios tempranos y los heteroespecíficos fueron diferentes alrededor del juvenil que en el ambiente. En el barbecho se encontraron cerca de rocas y hojarasca. Los sustratos favorables presentaron altos porcentajes de materia orgánica, bases intercambiables y capacidad de intercambio catiónico. Con estos resultados se busca entender mejor la dinámica sucesional en los Arbustales Altos y proponer acciones que mejoren las condiciones de establecimiento de especies de Alta Montaña importantes para la restauración en estos ecosistemas.

Communications: Communicating to a broader audience through story telling

Johns, David
Portland State University/The Wildlands Network, USA

Most restorationists know that the primary vehicle for communicating their purposes and goals to important audiences is story. But they do not always grasp the essential elements of persuasive and compelling stories—stories that lead to active support for restoration projects. Stories must appeal to an audiences needs, emotions and myths (what is sacred and just); they must be familiar; audiences must be able to find themselves in the story’s characters; they must be memorable and vivid; they must answer questions existing stories do not answer; stories must be conveyed with powerful symbols and tellable in a variety of media and time frames from soundbites to short and full-length films to books; and the messenger and channels must be right. There is no substitute for charismatic storytellers, but the elements of story can be mastered by others. And they must be if restoration is to have the support it needs to address the Earth’s many degraded landscapes before recovery become impossible on a human timescale. This paper will explain these elements of story, why they are important, and how restorationists can improve their use of them. The relation of story to other elements of mobilization will be briefly noted.
Political mobilization for large-scale restoration projects

Johns, David
Portland State University/The Wildlands Network, USA

Much of the terrestrial and marine portions of the Earth have been degraded by human activities and no longer support robust populations of all native species nor do they sustain ecological processes such as disturbance regimes or ecological services. Large-scale restoration projects are one of the most important responses to this situation because they address areas large enough to be meaningful to wide-ranging species, top predators, and complete river systems or ecosystems. Large-scale restoration projects face more obstacles and more recalcitrant opponents than smaller ones. For example, former US Secretary of the Interior Bruce Babbitt stated that multi-state restoration efforts involved too many players and opposed interests to successfully move them forward. Notwithstanding Babbitt’s observation, NGOs and social movements have achieved major change against enormous odds and conservationists can learn from their experience. The experience of successful movements, including their failures, suggests a number of critical factors that must be present, including perseverance, community building, a hard-nosed understanding of power and the willingness to use it, and others. The paper proposes concrete steps that can be taken to build support for large-scale restoration.

Genecology for developing seed zones and maintaining diversity of native plants

Johnson, R.C.; Brad St. Clair, Ken Vance Borland, Barbara Hellier, Nancy Shaw, Vicky Erickson, Matthew Horning, Erin Espeland
US Department of Agriculture

Rangelands support wildlife habitat, recreation, and grazing resources in many world regions. However, overgrazing, urbanization, climate change, frequent fires and invasive weeds are interacting to cause environmental degradation resulting in the need for restoration. In the past, most restoration projects have used cultivars or germplasm selected from a single location. As such, the ecological impacts or potential loss of genetic diversity across the landscape was generally not considered. Seed zones, areas guiding seed transfer, ensure that germplasm for restoration is ecologically suited and that diverse populations are maintained in situ. In the arid and semiarid western U.S., genecology research to establish seed zones is ongoing for key grasses and forbs. Across species, germplasm collected from widespread locations and used use in common garden studies have shown strong differences in plant traits associated with phenology, production, and morphology, indicating genetic variation across the landscape. Correlation has linked seed source temperature and precipitation patterns with numerous plant traits suggesting differences in adaptation were related to climate. Using multivariate plant traits, regression models relating plant traits to climate usually explain more than 50% of the total variation. Using these models and GIS methodology, seed zones have been mapped to guide seed transfer for restoration. The seed zone approach promotes the use of adapted germplasm that is ecologically suited, and promotes the conservation of genetic diversity needed for natural selection during the current period of rapid climate change.

Does a one-size-fits-all hydrology success criterion work when restoring wetland forests in North Carolina?

Johnson, Yari
North Carolina State University, USA

Wetland restoration for mitigation purposes in the United States uses arbitrary jurisdictional success criteria that are not based on ecology. According to North Carolina’s Natural Heritage Program there are twenty-four different wetland forest communities in the state; however, only one general hydrology success criterion is used for all during restoration for compensatory mitigation. It has been shown that species composition in wetland forests is closely related to edaphic and hydrologic gradients, e.g., slight changes in water table levels result in different species composition. In this study, we compared daily water table levels during the same time from nine reference sites to two mitigation sites that aimed to restore the same wetland forest community. These nine reference sites represent the natural variation of this community type. Twenty-five measures of water table condition were used to compare the references to the restoration sites. Previous research for this community showed that these measures of water table were strongly correlated with species composition. Our results show that one restoration site had higher water table levels than the reference sites, while the other restoration site had consistently lower water table levels. Restoration sites also had higher water tables levels during summer months and quicker changes in water table levels during and after rainfall events. Both restoration sites met their jurisdictional requirements for successful hydrology
for mitigation purposes, but their water table behavior was different from the reference sites. The current success criterion for wetland forests needs to be reevaluated.

**Electrically stimulated corals in Indonesia reef restoration projects show greatly accelerated growth rates**

Jompa, Jamaluddin; Suharto Eka, Marlina Anpusyahnur Putra, Nyoman Dwija, Jobnrico Subagio, Thomas J. Goreau

Hasanuddin University, Indonesia

Indonesian coral reefs have experienced intense degradation in the last few decades not only from anthropogenic factors e.g. destructive fishing, overfishing, coral mining, sedimentation, anchoring, and pollution, but also due to global warming that caused many Indonesian reefs to experience serious coral bleaching. In addition to the classical approach in saving the reefs through integrated/co-management, here we present alternative methods in accelerating the recovery of degraded reef through “Biorock” system. Corals of different reef building species were grown on electrically stimulated Biorock reefs at different locations in Southwest Sulawesi and Northwest Bali, Indonesia. All species of corals were found to grow significantly faster on Biorock at all sites than nearby controls. This increase ranged from 1) 4.01 times faster growth for Biorock *Acroporanobilis* versus controls in Bali at 4 and 6 m depth, 2) 2 to 3 times faster growth of *Acroporanobilis* at Biorock sites compared to controls in southwest Sulawesi at different voltages, and 3) 2 to 4 times faster growth of *Acroporaformosa* on Biorock than controls at another southwest Sulawesi site at depths of 5 and 9 meters. These results show clearly that coral growth rates can be greatly increased with electrical trickle currents for habitat restoration. The method shows clear utility for restoring coral reefs and fisheries habitat in degraded reef areas. Since the specific benefits differ between species, location, and charging conditions, further work is needed to optimize the method for different species.

**Ecology and restoration of Blackbrush (Coleogyne ramosissima) in the Mojave Desert**

Jones, Lisa

Texas State University, USA

Blackbrush, *Coleogyneramosissima*, is an emblematic shrub community dominating mid-elevations in the Mojave Desert, USA, which is currently threatened by frequent fire due to climate change and urban encroachment. I performed a complete factorial plot-scale experiment to quantify seedling emergence and survivorship as affected by the method of seed application (inside of soil/clay “seed balls” or bare), exclusion of mammalian predators (cage or no cage) and proximity to nurse plant. The experiment was repeated at three elevations. Across all elevations and treatments, germination from bare seeds was much higher than from seed balls. Emergence was overall highest at the highest elevation, where cages had strong positive effects. At lower elevations, the effect of nurse plants was stronger than the effect of cages. For survivorship, cages had predominantly positive effects and proximity to a nurse plant had either no or negative effects. Seedling density under cages after one year was highest at high elevation, but without cages, density was higher at low and mid-elevation. Our results suggest that, in its zone of dominance at high elevation, blackbrush recruitment is highly suppressed by seed and seedling predation, whereas at lower elevations, germination rates are more limiting, presumably due to hotter and drier soil conditions. Effective restoration at high elevation would therefore require high rates of seed application, whereas at lower elevation it should be conducted in high rainfall years. The use of seed balls is not recommended for this species.

**Managing landscapes for natural communities: Saving birds and a whole lot more in the Central Hardwoods Region**

Jones Farrand, Todd; Jane A. Fitzgerald, Lee E. O’Brien

Central Hardwoods Joint Venture, USA

Conservation planning at landscape and eco-regional scales requires an assessment of current conditions, restoration opportunities, and future threats. To meet this need for the Central Hardwoods Bird Conservation Region, we developed a set of decision support tools that can be linked together to assess the potential for successful conservation action. We assessed current conditions by modeling habitat suitability for priority forest-associated bird species from the 2001 National Land Cover Database and concurrent data from the Forest Inventory and Analysis program. We assessed restoration potential by modeling site suitability for 11 broadly-defined natural vegetation communities based on land-type associations, landform position, and assumed historic fire regimes. Additionally, we used expert opinion to characterize the vegetative structure of each potential community type to assess their habitat suitability. Finally, we assessed future threats by modeling future land cover change from predicted changes in housing density. Comparison of the potential landscape to current conditions suggests that glade, savanna and
woodland communities have the greatest potential for restoration. If undertaken, restoring these communities could stabilize or reverse declines of associated bird species, but must be balanced against interior forest habitat loss. Further, the long-term success of restoration efforts will be influenced by further development pressure. This research provides a framework for setting regional avian population and habitat objectives, as well as for identifying priority landscapes and sites for conservation efforts that will benefit a broad array of taxa.

**Restauración hidrológico-forestal en zonas áridas y semiáridas de la Región de Coquimbo, Centro-Norte de Chile: Valoración y difusión desde la experiencia de dos comunidades locales**

Jorquera Jaramillo, Carmen; Julio Gutiérrez-Camus, José Luis Cortés-Bugueño

Universidad de la Serena, Chile

En Chile árido y semiárido, la recuperación de la cubierta vegetal (principalmente con especies exóticas) y el manejo conservacionista de los suelos bajo el concepto de restauración hidrológico-forestal, financiados vía subsidios adjudicados por el Decreto-Ley N° 701, sólo se evalúa en función de la sobrevivencia de las plantaciones hasta 2 años de implementadas las acciones. Sin embargo, no se considera un seguimiento posterior de variables biofísicas ni del aprendizaje y difusión de las prácticas entre los usuarios locales. Aquí se analiza el efecto multiplicador de dos experiencias-modelo de restauración hidrológico-forestal realizadas en dos provincias del norte-centro de Chile, en el contexto de dos organizaciones territoriales comunitarias y sistemas de tenencia de distinta naturaleza. Aunque existen variaciones en la apreciación de los beneficiarios finales, también hay coincidencias respecto a los beneficios globales de las experiencias de restauración. A pesar de las diferencias en las dinámicas internas de las organizaciones y en el nivel de participación y compromiso de la población local en la implementación de las experiencias demostrativas, se constata un aumento en la adopción de las prácticas por parte de la población rural local.

**If there is no balance of nature, how can it be disturbed?**

Jurskis, Vic; John Turner

Forests New South Wales, Australia

Australia has seen major changes under human influence. Occupation 50,000 years ago brought increased burning. Mesic flora and browsing megafauna yielded to grass, grazing animals and sclerophyll trees. Woody biomass and charcoal deposition declined as frequent fires shaped ecosystems. Europeans disrupted the balance, promoting woody biomass, severe fires and pests of Eucalyptus. Rabbit plagues exacerbated overgrazing by domestic stock during drought. Disastrous wildfires in the mid 20th Century prompted extensive prescribed burning and myxomatosis controlled rabbits. At this time fertilization and sowing of pastures accelerated eucalypt decline in rural lands whilst river regulation changed floodplains throughout the Murray Darling River Basin. Over the past three decades conservation areas increased and prescribed burning decreased with a consequential resurgence of forest decline and disastrous wildfires. This rich ecological history answers some basic questions about disturbance, resilience and man’s role in nature. We propose that succession is an evolution over geological time after the balance of nature has been disturbed by changes beyond the natural amplitude. Its end point will be a resilient system whose components are in dynamic balance. Natural factors such as drought, flood and traditional human practices have been classed as disturbance but in fact maintain a balance. Removal of any such factors is a true disturbance, favoring some organisms over others and altering ecosystem structure, function and composition. New evolutionary processes with unpredictable consequences are set in train. We illustrate this with examples of ecological history from each inhabited continent. Human economy is essential to conservation and restoration.

**Returning the lost mangroves: An African experience**

Kairo, James G.; Jared Bosire, Benard Kirui, Joseph Langat

Kenya Marine and Fisheries Research Institute

Like other mangrove areas in the world, mangroves of Africa play quite significant ecological, socioeconomic and climate amelioration functions: supporting high flora and fauna diversity; providing direct wood and non-wood products and services to the people in terms of building poles, charcoal, tannins, firewood; shoreline protection and also serving as reliable carbon sink. Despite these roles and services, mangroves have been severely impacted over the years, with West Africa reporting a 20-30% loss and Eastern Africa an 8% loss within the past 25 years. Loss of mangroves has affected local and national economies as witnessed by shortage of firewood and building materials; reduction in fishery; and increased shoreline erosion. Conservation alone will not reverse these problems; concerted effort on mangrove reforestation and management is needed if we are to achieve the objectives of sustainable coastal
development in Africa. The Kenya Marine and Fisheries Research Institute, in Kenya, has been spearheading science of mangrove management in Africa. Program activities include mapping and surveying of mangrove resources, awareness creation, and reforestation of degraded areas. Plantations established in the 1990’s in pilot areas of Kenya are ready for harvesting. This presentation will review personal experiences on mangrove reforestation in Africa through partnership with NGO and mainstream government departments.

**Community translocation as a tool for assessing restoration targets and instilling ecological resilience with climate change**

**Kalk, Hannah; Loretta L. Battaglia**  
Southern Illinois University, Carbondale

Accelerated sea-level rise and increased intensity of tropical storm events have challenged conventional approaches to the conservation and restoration of coastal ecosystems. In coastal communities, where survival will depend largely on the ability of species to adapt to rapidly shifting conditions or establish farther inland, historic assemblages may be lost. Climate change is already affecting coastal communities, and storm surge disturbances in the Northern Gulf of Mexico, USA, have resulted in the federal buyout of hundreds of properties for which appropriate restoration targets are unclear. Community translocation, the intentional relocation of suites of species within or outside of their native range, may provide an opportunity to instill ecological resilience and ease the transition of these sites to futuristic communities better adapted to future conditions. In this study, translocation of propagule sods from historical plant communities spanning a coastal transition at Grand Bay, Mississippi onto degraded properties resulted in the establishment of diverse and variable communities, containing target species from seaward and landward community zones. The response of vegetation following application of freshwater marsh and maritime pine island sods suggested that these assemblages may be best suited to the restoration sites. Propagule banks of wet pine flatwoods, a community of particular conservation concern, also responded favorably. Variation among sites suggests that local environmental conditions and proximity to source populations also drive the resulting community dynamics. Long-term monitoring of community change and reproductive output of target species will indicate the utility of translocation in creating resilient and future-adapted communities.

**Natural farming: Biodiversity agriculture by Japanese farmers**

**Kaneko, Nobuhiro; T. Nakamori, T. Miura, M. Arai, A. Yagioka, M. Komatsuzaki**  
Yokohama National University, Japan

Late Masanobu Fukuoka proposed "natural farming", no tillage, no chemicals, no weeding, as a sustainable agricultural method. Some Japanese farmers modified his method and are getting excellent harvest with minimum labor. They try to minimize tillage and keep weeds all the time, thus weeds are controlled by hand cutting to avoid excess competition with crops. We investigated soil fungal (T-RFLP method) and faunal biodiversity (microarthropods and earthworms), soil structure (water stable aggregates) and carbon sequestration at natural farms with different management history and operation years in central part of Japan. Due to the minimum disturbance to soil and a plentiful supply of organic matter from weeds (litter and root), there was increased soil carbon content in the upper layer of soil. Earthworm casts enhanced water stable aggregates in the soil. Soil biodiversity was higher in the natural farming than conventional tillage: more fungal OTU and earthworm species were found in the natural farming plots. Same relationship was confirmed in experimental plots established recently in two universities. Increase of above ground plant species richness and biomass enhanced soil biodiversity, biomass and soil carbon, and this in turn supported plant growth without addition of fertilizers. Natural succession happening at cropland is well controlled by hand cutting of aboveground part of weeds. We discuss this from an ecological viewpoint.

**Interpreting restoration success: Effects of scale and species identity**

**Kareksela, Sanu; Hilja Vuori, Tuomas Haapalehto, Janne Kofialo**  
University of Jyväskylä, Finland

In a rapidly changing world ecological restoration has become more and more recognized method to fight habitat degradation caused by humans. To assess the usefulness of the various methods, the results of restoration actions need to be monitored and measured. There are numerous ways to measure and interpret possible changes in ecosystems, communities and populations. However, different perspectives, even on the same data, may reveal effects that give quite different interpretation of the results of a restoration action. We demonstrate this using a pre-restoration monitoring data from a large peatland restoration monitoring network consisting of 120 peatland areas across Finland. Our results reveal different features of the data depending on the scale of monitoring area and the
accuracy of species identity. We demonstrate that especially when measuring a relatively rapid change in species composition at community level, it is very important to pay attention to the areal unit used as rapid changes are rarely homogenous over a habitat. In addition, we show how the change of the measured variable from species number to more accurately defined species compositions can have a major impact on the interpretation of the results.

Utilization of Low Voltage Electricity to stimulate cultivation of Pearl Oysters *Pinctada maxima* (Jameson)
Karissa, Prawita Tasya; Sukardi, Susilo Budi Priyono, N. Gustaf F. Mamangkey, Joseph James Uel Taylor
Gadjah Mada University, Indonesia

The utilization of low voltage electricity to accelerate organism growth has been applied for ecosystem restoration, but has many mariculture applications. This study examined potential use of low voltage electricity for early growth of the pearl oyster *Pinctada maxima*. This research was conducted in August through October 2006 at a pearl oyster farm in Sanggalangit Village, Gerokgak District, Buleleng, Bali. The experiment was conducted using factorial design 3x2 with 4 replications. There were 3 treatments namely: no electricity, electricity without mineral accretion, and electricity with accretion, as well as 2 treatments with oyster ages of 6 months and 10 months. Electrical treatments used two wet batteries 11A 6V as power supplies wired in parallel. Electricity ran at 2 volts for 4 hours daily on electricity treatments both with and without accretion. The number of living oysters, shell length and wet weight were calculated and measured at the beginning and the end of experiment. Results showed that the oysters reared using low voltage electricity have significantly higher survival rate compared to the oysters reared without electricity. Oyster 6 months old reared by electricity without accretion and oyster 10 months old reared by electricity with accretion, were found to have the highest growth. These results suggest that hatchery and grow out operations could be faster and have higher survival using electrical stimulation, but more work is needed to determine the optimal conditions for oyster production for mariculture and ecosystem restoration.

Protected areas restoration in a rapidly changing world: Policy and management implications of novel ecosystems
Keenleyside, Karen
Parks Canada

Global policy for biodiversity conservation and protected areas is increasingly responding to the challenges posed by rapid biodiversity loss and rapid climate change by calling for enhanced efforts to restore degraded ecosystems. At the same time, the emergence of novel ecosystems with no historical or contemporary analogues presents challenges for developing practical targets for restoration projects and programs. In this presentation, we demonstrate how domestic and international policies aimed at protecting biodiversity in intact ecosystems, enhancing ecological connectivity between protected areas, connecting people with nature, and restoring the ecological integrity of ecosystems can support actions that provide multiple benefits for people and nature. We argue that protected area restoration goals that integrate concepts such as ecological integrity and resilience and respond to social and cultural priorities for the provision of ecosystem services will help protected area managers develop pragmatic targets for restoring protected area values in a rapidly-changing world.

Key elements of best practice in protected areas restoration – Overview of international guideline development
Keenleyside, Karen; S. Cairns, C. Hall, N. Dudley, S. Stolton
Parks Canada

Protected area scientists, managers and other experts from around the world are working with the IUCN’s World Commission on Protected Areas to develop best practice guidelines for ecological restoration in and around protected areas. This presentation provides an overview of key elements of best practice that are emerging through this work and identifies how such guidance will help protected areas managers address some of the key challenges they face in planning and implementing ecological restoration projects and programs.
Climate Adaptation Knowledge Exchange (CAKE): An online tool to incorporate climate change into restoration projects

Kent, Livia
Island Press, USA

Most people involved in restoration projects are already practicing climate adaptation at some level. At the very least, they recognize the impacts of climate change and are considering ways to respond to it. Adaptation protects our ecosystems by strategically factoring the impacts of climate change into planning and resource management. Given that restoration practice trains people to monitor what’s happening and make adjustments as needed, practitioners in this field are ideally positioned to advance climate adaptation efforts. Whether actively engaged in adaptation strategies or new to the concept, anyone working to restore and maintain resilient ecosystems in the face of rapid climate change will find CAKE, an online climate adaptation knowledge exchange, to be an invaluable resource. CAKE offers a common, approachable forum for people across disciplines and sectors to share resources, data, and tools related to climate adaptation. This presentation will take audience members on a dynamic tour of CAKE and the georeferenced resources available for incorporating adaptation strategies and best practices into restoration work. It will explore case studies in a variety of coastal ecosystems, such as salt marshes and estuaries, while also showcasing how each study is uniquely linked to the tools and reports used in planning, as well as to the people involved in the project. Additionally, it will demonstrate how users in the restoration field can contribute their own case studies and literature and join an interactive community of people practicing climate adaptation.

Silvicultural restoration of second-growth redwood forests: Challenges and strategies

Keyes, Christopher
University of Montana, USA

In parks and reserves of northern coastal California (U.S.A.), second-growth redwood forest restoration has rapidly become a dominant management paradigm. With most remaining old-growth redwood forests now in protected status, the focus of biological conservation efforts has shifted to the region’s vast second-growth forests. Second-growth redwood forests are characterized by high stand densities, species composition imbalances, and simple stand structures. To remediate these conditions and promote forest ecosystem complexity, the potential of silvicultural restoration (new practices and novel adaptations of traditional practices) is great. For this purpose, forest stand dynamics serves as the fundamental basis for identifying restoration needs, prioritizing stands for treatment, and designing site-specific prescriptions. This presentation summarizes restoration needs in second-redwood forests, and describes key observations of recent applied ecological research and experimental treatments performed at Redwood National Park, Humboldt Redwoods State Park, and other reserves. The unique objectives and challenges of redwood forest restoration in parks and reserves are discussed.

Valuing indigenous knowledge for restoration of mangrove ecosystem to changing climate

Khan, Saleem; A. Ramachandran
Anna University, India

Traditional societies in many cases have built up knowledge over long periods about changes in the environment and have developed elaborated strategies to cope with these changes. However, traditional knowledge systems in mitigation and adaptation have for a long time been neglected in climate change policy formulation and implementation and have only recently been taken up into the climate change discourse. Traditional and indigenous people, who have survived over long periods to many kinds of environmental changes, including climate change, may have valuable lessons to offer about successful and unsuccessful adaptations which could be vital in the context of climate change. More importantly, long-term place-based adaptation approaches developed by indigenous people provide valuable examples for the global community for ecological restoration, critical to developing local adaptations strategies in the face of climate instability. Thus, the scope of this research is to reveal the indigenous and traditional knowledge of mangrove dependent community to strengthen the resilience and to restore mangrove ecosystem to changing climate. In this context, this case study investigate and document the indigenous knowledge of Irulas, the unique mangrove dependent community of the Pichavaram mangrove region of Tamil Nadu, India and also find ways to bridge knowledge gap with scientific community for framing better and effective mangrove restoration plan. More specifically, the management of mangrove restoration as a climate change adaptation measure is addressed in this regard.
The semiotics of ecological authenticity in restoration: The case of the Cheonggyecheon restoration project in central Seoul

Kim, Sung Do
Korea University

The restoration of the Cheonggyecheon stream that runs from west to east through the central Seoul is recognized as a paradigm shift in contemporary urban design and ecological restoration. Many scholars considered diverse aspects of this remarkable project such as the ecological, historical, cultural, political, economic impacts. Beyond these impacts of different domains, this seminal project signaled a major turning point in urban ecology and ecological restoration in Korea, from a focus on industrialization and modernization to a different emphasis on livability, sustainability and ecological consciousness. However, this project produced a wide range of critical urban discourses from its inception to the present including some radical debates spanning the full ideological and political range. In fact some critics strongly believe that the restored stream lacks the ecological and historical authenticity that could have been generated through a real ecological restoration: indeed, it was severely criticized as a civic space decorated with nature, as an artificial urban waterfront or as a distortion of the original. In this paper, I will propose a semiotic reading on this issue of ecological authenticity in restoration in focusing the ecological and historical character of the restored Cheonggyecheon. In sum I will try to reveal the semiosphere - the field of meaning formation - of Cheonggyecheon from the diachronic point of view: from its geomantic significance to symbolic revivification of the historical and natural heritage through the historical repetition of denaturalisation and re-naturalisation of this stream.

The role of social capital in community-based rangeland restoration in Kenya

King, Elizabeth; Eva Kaye-Zwiebel
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Planning for the future while a social-ecological system is in transition is a common challenge that is rightly becoming a priority in research on institutions, resource management, and social resilience. Historically, traditional pastoralist communities in Kenya have relied almost entirely on livestock, mobility, and social reciprocity for their subsistence livelihood. Today, as a result of human population growth, political and development influences, and climate change, pastoralist systems are undergoing profound transformations, including reduced human and livestock mobility, greater income diversification, various forms of social fragmentation, and also increasing efforts to reverse land degradation. Because social capital is a critical component of a community’s adaptive capacity, we studied five Laikipia Maasai communities to evaluate what forms of social capital correlate with land management success, and how different characteristics of social networks facilitate or hinder collective action for ecological restoration. To do so, we integrated cross-community social capital assessments and within-community case studies of restoration initiatives. We utilize our findings to reflect on local residents’ goals for future land use, their likely ability to meet these goals, and the influence of internal and external power brokers on land restoration and stewardship initiatives.

Ecological restoration with native seeds from species-rich grasslands

Kirmer, Anita; Annett Boasch
Anhalt University of Applied Sciences, Germany

Highly disturbed areas such as surface-mined land provide a great challenge for ecological restoration searching for appropriate approaches in a continuum between technical reclamation and spontaneous succession. In particular on sites endangered by erosion, appropriate methods are needed that quickly establish vegetation cover but also take into account the natural potentials of the sites. One way to satisfy both requirements can be the creation of species-rich grasslands using hay transfer and sowing of native seeds to accelerate and direct vegetation development. In the post-mining landscapes of eastern Germany, two large-scale trials were implemented in September 2000 and December 2004, using the following methods to start vegetation development on bare slopes with nutrient-deficient raw soil: (1) spontaneous succession (untreated control); (2) low-diversity seed mixture (3 grass cultivars); (3) medium-diversity seed mixture (21 native species); (4) high-diversity seed mixture (51 native species); (5) seed-rich green hay (97 directly harvested native species). Until summer 2010, we assessed differences of speed and pathway of vegetation development of all variants as well as their susceptibility to immigration events via seed rain. During the whole observation period, establishing rates of target species remained high. Variants using native seeds showed a faster vegetation development and a higher share of target grassland species. The results presented demonstrate that hay transfer and sowing of native seeds are very successful in developing species-rich grasslands on marginal land, thereby contributing to the enhancement and preservation of regional biodiversity.
Return of ecological keystone sedge species through plant tissue culture

Kodym, Andrea; Shane Turner, Eva Temsch, Eric Bunn, John Delpratt

University of Melbourne, Australia

Many iconic Australian species are not available for revegetation because of the lack of efficient propagation methods. Among this group of plants are many Lepidosperma species (Cyperaceae, sedges) which are widespread and significant understorey species of various native plant communities. In vitro techniques are being investigated to produce large quantities of planting material for restoration programs. Seeds of Lepidospermaconcavum, L. laterale and L. longitudinale germinated in vitro after removal of the pericarp. Germination ranged from 83-86% within 5 weeks on 1/2MS medium with 1 µM zeatin and 10 µM gibberallic acid. In vitro plants were successfully stored without subculturing at 14 °C under low light conditions for at least one year. Micropropagation in L. laterale was initiated using shoot culture. Micropropagation rates were 1.3 – 2.8 over a 6 week period on medium containing BAP while shoots rooted easily on IBA medium. As a tool for mass propagation and in preparation for the production of artificial seed, somatic embryogenesis was also studied. Embryogenic callus was induced from immature seed and from in vitro grown seedlings on medium containing 2,4-D and zeatin. Induction was 14% and 93% respectively after 8 weeks. High rates of conversion to plants were achieved on charcoal medium followed by thidiazuron medium. Acclimatisation of rooted plants was 95%. Flow cytometer measurements determining ploidy level were carried out on plantlets regenerated from callus. Lepidosperma plants are now becoming available on a large-scale to the revegetation and horticultural industries.

Mangroves: Is restoring the forest restoring its functions?

Koedam, Nico; J. G. Kairo, N Mukherjee, J. O. Bosire, M. O. S. Mohamed, R. Merken, F. Dahdouh-Guebas

Vrije Universiteit Brussel, Belgium

Mangrove forests, which cover tropical and subtropical coasts worldwide, are floristically simple formations. Especially when comparing to terrestrial forest at a same latitude, the low number of species constituting a mangrove is striking. Besides being floristically poor, mangroves lack a shrub and herb layer, apart from mangrove tree recruitment itself. This makes the physiognomy of mangroves also simpler than most terrestrial forests. Such absence of complexity suggests simple ecological relations between these primary producers and other biota as well as straightforward and easy restoration. Restoration of mangroves has become a priority in many countries. The incentives are the fast disappearance of mangrove formations under human pressure over the past decades until today, and the environmental problems this entailed. Mangroves constitute coastal formations offering many ecosystem services, both as primary producers and for derived resources, and through their structural role as coastal and estuarine forests. In view of the species paucity, restoration paradoxically had mixed success rates worldwide. Besides remediating failure to re-establish mangrove forests, the restoration of ecological functioning of this ecosystem must also be considered. We report about the ecological functionality of mangrove forests in Kenya (East Africa) where we compared pristine mangrove forests, human-impacted forests and forests which have been restored over more than a decade. Insights gained from this model case are analyzed against insights from other mangrove areas worldwide.

Photovoice for local ecological knowledge and perceptions on restoration and management practices and assessment indicators in the Kalahari

Kong, Taryn

University of Arizona, USA

Natural resource researches that aim to gather local ecological knowledge (LEK) from community participants need a methodology that is versatile enough to capture diverse knowledge and to be accessible to as many participants as possible. This study examined the use of photovoice as a data collection technique of farmers’ local knowledge and perceptions of rangeland restoration and management practices and assessment indicators in the Mier area of the Kalahari in South Africa. Photovoice is a community-based participatory research (CBPR) method, which uses subject-generated photo-essays coupled with critical reflective discussions among participants as an empowerment tool. Its potential as a data collection methodology for participatory researches in natural resource management has, however, been little explored. Our study presented a particular challenge because our participants, livestock and game farmers, are from a wide range of socio-economic backgrounds. Their LEK varies as much as their backgrounds and the different environments in which they live and work. Our results showed that photovoice could be modified to enable our participants, most of whom had never used a digital camera before, to convey their LEK and perceptions. Photovoice gave them an opportunity to reflect on the research topics and an alternative medium to
express their inputs in rich details. This was particularly useful for those who are less comfortable with written words. They used their photographs to share their knowledge and experiences with others beyond the scope of the project. Photovoice also resulted in greater participation by women and youths.

**A practical genetic contribution towards best-practice seed-sourcing guidelines for ecological restoration**

Krauss, Siegy; Liz Sinclair, Eleanor O’Brien
Kings Park and Botanic Garden, Australia

Whilst there remains an on-going need to research the consequences of seed-sourcing decisions associated with the provenance and properties of source populations, restoration practitioners urgently require practical and specific seed-sourcing guidelines to achieve key objectives for current ecological restoration activities. For the restoration of highly diverse plant communities, this requirement often extends to hundreds of species. To address this practical need, we have utilized powerful molecular markers, an efficient sampling approach and novel statistical procedures to generate data on spatial genetic structure for many species associated with ecological restoration projects in southwest Australia. A general finding of significant genetic structure, a positive association between geographic and genetic distance, and marked population differentiation, reiterates the importance of local provenance sourcing of genetically diverse seed. Examples of our approach are presented for keystone tree species, from which general seed-sourcing principles are identified.

**Building resilience during restoration**

Lamb, David
IUCN Commission on Ecosystem Management/University of Queensland, Australia

This introductory presentation provides a framework for the symposium and offers a view of resilience that includes ecological, economic and social elements. Resilience is needed to ensure ecosystems are robust and able to withstand future changes or disturbances. It is less of an issue when full-scale ecological restoration is being undertaken but is more important when novel ecosystems are being created that may involve only a sub-set of the original biota together with some exotic species. The presentation will explore some ecological, economic and social factors likely to enhance resilience and some of the questions needing to be resolved (e.g. how many species are needed to foster sufficient resilience? how to make production vs resilience trade-offs?). The intent of the presentation is to provide a context for the succeeding presentations and the discussion that will follow.

**Responses of the salt marsh fish community to potential impacts and restoration after the 1991 Gulf War oil spill**

Langman, Owen; Sharook Madon
Pandion Technology, Ltd., Saudi Arabia

Efforts to restore salt marshes in the wake of the 1991 Gulf War oil spill on the eastern coast of Saudi Arabia will affect both resident and transient fish populations. Varying degrees of natural recovery have occurred in the two decades since the spill, but a number of feedback mechanisms primarily related to the expansion of thick, laminated algal and diatom mats have ensured that the diversity and abundance of prey items, access to the marsh plain, and natural hydrologic activity remain impaired in many of the marsh systems. Six marshes, including three reference marshes and three degraded marshes covering a range of natural recovery, were fished as part of a whole-ecosystem monitoring program to establish the diversity and relative abundance of the fish populations exploiting the marsh during periods of tidal inundation. Three fish found to commonly exploit the marsh include a marsh resident omnivore (*Aphanius dispar*), a transient surface feeding omnivore (*Hemiramphus marginatus*), and a transient benthic carnivore (*Sillago sihama*). Individuals of these three species were captured during ebb tide after a monthly high and dissected to establish forage items consumed and forage success during marsh inundation. Gut weight and contents displayed marked differences for all three species across the range of impacted and reference sites. Differences were related to marsh characteristics derived from the larger monitoring program, and potential responses to the planned restoration activities are considered. Recovery of the vegetative community and access to the marsh plain were the dominant factors impacting the fish community.
Biochar: the optimum geotherapy approach?
Larson, Ron
United States Biochar Initiative

“Biochar” is charcoal placed in soil. The word was coined only in 2007 – with Biochar’s geotherapy importance recognized not much earlier. Probably its greatest geotherapy strength is based on thousands of years already of soil-augmentation. Using mainly charcoal, pre-1500's Amazonians turned arguably the world's worst soils into some of its most productive, thereby avoiding slash-and-burn agriculture. Five centuries later, those soils provide triple soil productivity (and sextupled land value) over “parent” soils only meters away. But equally important is Biochar's also newly recognized capability to restore our increasingly polluted atmosphere. Rather than decaying biomass returning its parent CO₂ to our atmosphere, conversion to Biochar almost-permanently sequesters that same CO₂. Biochar can thereby restore the more hospitable biosphere that shaped places like Merida and the Yucatan. While serving these two valuable “carbon-negative” geotherapy functions, a third benefit is that up to half of the plant carbon can also expand/support the inherently variable carbon-neutral solar and wind energy resources needed to get to zero fossil fuel use.. These three primary “out-year” advantages seem to best utilize the huge-expandable-but-finite, still-insufficiently-valued biomass resource. Secondary benefits include waste disposal, reduced fertilizer use, nutrient recycling, water retention, reduced N₂O and methane emissions, job creation, and rural economic development. The world faces a choice to invest or expend: millennial-payback Biochar versus one-time, single-purpose, non-soil use of the same biomass. Issues of possible scale (possibly near today's fossil carbon inputs), costs, food-conflicts, biodiversity, social impacts and needed subsidies will also be addressed.

Restoring the Yaxunah Cenote: A design/build case study
Lawlor, Josie; Iona Bruckner, Grace Bascope, Lauren Rochelle

This article investigates how the Yaxunah indigenous community restored the sensitive landscape around their Cenote and the process and factors that made this possible. Cenotes, or karstic pools, are the main source of fresh water on the Yucatan peninsula and form the centers of many Mayan communities. In Yaxunah the degraded landscape around this ecologically and culturally important site was rehabilitated through a partnership between the community and a non-profit group. Landscape designers and horticulturalists facilitated a collaborative design-build process with villagers to come up with a new layout for paths, walls and plantings, and to construct the improvements. Native plantings now slow and filter runoff water that once carried contaminants directly into the aquifer. New paths give villagers safe access to the water. During this project the community carefully considered how their cenote functions: environmentally, as part of the ecosystem and aquifer; culturally, as the center of town life; and economically, as part of the eco-tourism industry. The unique approach provided the opportunity for villagers to shape their new landscape and incentive for them to take ownership of the natural feature. The Yaxunah Cenote Project demonstrates that collaborative design-build projects aimed at restoring natural capital can be an effective way to bring knowledge, interest and ownership to natural assets, ultimately strengthening the link between nature and culture.

Hay transfer to restore rupestrian fields, physiognomy of Cerrado threatened by land-use changes
Le Stradic, Soizig; Elise Buisson, Geraldo Wilson Fernandes
IMEP-UMR, CNRS/IRD, France

Rupestrarian fields or campos rupestres are located in eastern Brazil between 800m and 2000m and are a more or less continuous herbaceous stratum with sclerophyllous evergreen small shrubs growing between rocky outcrops. They are a physiognomy of the biome Cerrado a type of savanna. The soils are shallow, sandy, highly acidic and poor in nutrients with one of the highest level of endemism in Brazil. Currently, the Cerrado is one of the most endangered biome of South America, threatened by intense anthropogenic pressures. In this context, ecological restoration studies are urgently needed. This study tests the transfer of herbaceous native species from rupestrian fields to three kinds of degraded areas (with stony substrate, sandy substrate and ferruginous substrate). The first year hays collected on two types of rupestrian fields (sandy and stony) in November were transferred, manipulating several levels of 3 treatments in a multifactorial experiment: weeding/plant interactions, nutrient addition/no fertilization, hay from stony site/from sandy sites/no hay. As experiments were not conclusive, the second year hays were collected all along the year to increase seed pool in three types of rupestrian fields (stony, ferruginous and sandy). Hay was spread out as follows: hay from stony sites on stony substrate, hay from ferruginous sites on ferruginous substrate and hay from sandy sites on all substrates. Results will be discussed and further restoration actions will be proposed.
Fisheries restoration by post larval restocking

Lecaille, Gilles
ECOCEAN, France

Coastal fisheries are in collapse, yet most juvenile fish populations undergo planktonic development and are lost to predation before they can find shelter. We present a new approach, using simple technology to “rescue” a small proportion of wild tropical post-larvae fish populations (with complete biodiversity and genetic variability), short circuiting predation losses. After capture, the fish are reared and released as 3-month old juveniles into coral reefs and other coastal marine habitats undergoing restoration. This operational solution requires on-site training and capacity building in sustainable Post-larval Capture and Culture (PCC) technology. PCC technology has already been tested in many developing countries in South East Asia, the Pacific, Indian Ocean, and Caribbean. There are numerous benefits, especially for small island countries. PCC technology can offer immediate alternative income for local fishermen and implementing biodiversity monitoring to improve basic knowledge of fish stock restoration. PCC can rebuild adult stocks of local species for commercial and artisanal fishing, and mitigate for human impacts such as overfishing, coral reef and habitat losses, global climate change, oil spill pollution, and disasters. We will present case studies using post-larvae fish in coral reef restoration including grouper replenishment (Reunion Island), fishermen’s involvement within Marine Protected Areas (Madagascar), guest fees to restock coral gardens (Fiji, UAE), and boosting resilience of MPAs (Philippines). We also explain how PCC technology can help rebuild damaged fish populations after disasters such as oil spills, earthquakes, or tsunamis. Coupled with habitat restoration, PCC technology will be the fastest way to restore coastal fisheries.

BioRestore®: An operational solution for accelerating the regeneration of marine coastal biodiversity in compliance to French regulations

Lecaille, Gilles; Phillipe Lenfant, Eric Blin
ECOCEAN, France

The earliest EU framework directive (1979 for birds and 1992 for Habitat) is now well implemented, while the first milestones for the water and environmental framework directives (2000) are coming up. The recent EU marine framework directive (2008) imposes specific objectives for different countries. As a result, the French government is now obliged to reduce marine biodiversity losses, to improve knowledge about the life cycle of marine organisms, and to propose operational solutions to halt and reverse biodiversity loss. BioRestore® makes it possible to address both existing EU legislation (e.g. mandatory mitigation measures, etc.) and proposed new legislation. It will also contribute to help mitigate ongoing overexploitation of marine resources. The idea is to effectively ‘rescue’ a small proportion of post-larval fish before predation, then rear and release them to boost marine ecosystem recovery. Restocking can thus be achieved for a wide range of coastal fish species, and pre-release juveniles are conditioned to survive in the wild before restocking. We feed them on live food, and a patented ‘halfway house’ is assembled in the nursery where the fish can become familiar with it. Pieces of the ‘halfway house’, are then released in the same area as the fish, thus reducing stress and encouraging the juveniles to settle at that location. In full accordance with the maritime status quo and the regulatory context, BioRestore® provides simultaneous responses to current French regulation objectives, and could be of interest elsewhere. We will briefly describe ongoing projects in other Mediterranean coastal waters.

Recovery landscape connectivity by TEK in the Lacandon rainforest

Levy Tacher, Samuel Israel; Francisco Román Dañobeytia
El Colegio de la Frontera, México

Current approaches to the study and development of land-use systems in indigenous territories and landscapes of Neotropical regions draw upon conceptual and methodological frameworks derived in part from traditional ecological knowledge (TEK). Notwithstanding the effectiveness and promise of these approaches, TEK has been mostly neglected by tropical ecologists, foresters and agronomists in the definition and implementation of novel land-use practices aimed to rehabilitate degraded lands and their vegetation. Taking into account the scope and importance of this knowledge, the procedure and conceptual bases that served to support the actions for the Lacandón rain forest ecological rehabilitation will be discussed. In this sense the strengths and weaknesses of the TEK will be described, the different traditional techniques useful for rehabilitation, as well as the proposed method and the more frequent problems we have faced. The application of this knowledge is illustrated with a project that began in 2005, in the community of Nueva Palestina, Lacandon rainforest, where actions were performed to rehabilitate degraded areas on a large scale. The project takes into account the TEK and is based on the
characterization and mapping of the areas of intervention, the propagation of 20 native tree species of commercial interest, the link with governmental and academic institutions and the participation of around 230 peasants with 350 ha in the process of rehabilitation.

**Restoration of abandoned aquaculture ponds back to mangrove forests**

**Lewis, Ray; B. Brown, R.F. Dennis**

Lewis Environmental Services, Inc., USA

It is estimated that up to 50% of the historical extent of 38 million ha of mangroves may have been lost over the last 100 years. We estimate that as of 2010, approximately 400,000 ha of aquaculture ponds constructed in former coastal wetlands, including mangroves, salterns and tidal marshes have been abandoned worldwide. Our goal is the restoration of these ponds back to wetlands. We use and teach to local indigenous village groups the Ecological Mangrove Restoration (EMR) methodology and the application of selective breaching to reduce overall costs. EMR emphasizes hydrologic restoration by humans, and not just mangrove planting. This restoration methodology has been successfully tested in Don Sak, Thailand, and Tiwoho, North Sulawesi, Indonesia, and is currently being applied at Tanakeke Island, South Sulawesi. The restoration of tidal streams is an essential part of the hydrologic restoration of functional and persistent mangroves. The persistence of a tidal stream is related to a number of relatively obscure functional attributes such as the existing tidal prism, connectivity to adjacent open oceanic waters and upland freshwater drainage, and historical modifications of these hydrologic features.

**Ecological restoration as a tool to restore social rights and duties**

**Liddle, Leanne**

Department for Environment and Natural Resources, Australia

Despite the magnitude of international conventions on human rights and biodiversity, as well as the recognition of ownership and control of land, across the world, many Indigenous people’s capacity to access, use and control natural resources remains marginalized. Scientists who work on Indigenous lands with Indigenous people exclusively focus only on the economic and environmental benefits in natural resource management. They routinely ignore or limit the social and cultural functions of ecosystems, which are critical components to ensure Indigenous participation and benefits in ecological restoration. Once these social and cultural functions are marginalized, the integrity of the landscape is suppressed as well as the ability of scientists to utilize fully the knowledge, skills and the benefits of Indigenous people to restore biodiversity and ecosystem functions. Ecological restoration must be implemented within governance and knowledge frameworks that respect Indigenous rights and cultures, including rejecting Western binaries of nature-culture and human non-human. This presentation will focus on the presenter’s experiences in the western desert region of Central Australia and will identify the barriers and benefits to the environment when collectively the social, cultural and environmental elements are fully engaged by Scientists.

**The benefits of Indigenous use of fire in the arid zone: Fact or fiction?**

**Liddle, Leanne; Cecilia Woolford**

Department for Environment and Natural Resources, Australia

Indigenous use of fire in the central desert of Australia has been performed by Aboriginal people for nearly 75,000 years. It is this knowledge and its application recorded and transferred through generations which has maintained the integrity of the landscape in the traditional desert Anangu Pitjantjatjara Yankunytjatjara Lands. However, in Australia, for the past 210 years, western science has since encroached into the once uninterrupted foundation of Indigenous knowledge. This encroachment is evident in the strategies, methods and purpose of fire and the interpretation of the landscape including differences in values and cultures. For Aboriginal people this difference has the potential to erode away the critical knowledge and intent of fire within the landscape which has the effect of significantly altering the landscape and culture. This paper poses the challenge, of whether the marrying of science and indigenous knowledge is really beneficial to the landscape and whether such differences are in competition can work co-operatively, or if the combination of this knowledge is actually benefiting the landscape.

**The collision and coincidence of science and Indigenous customary law**

**Liddle, Leanne; Stephen Forbes**

Department for Environment and Natural Resources, Australia
Kuka Kanyini is a model for wildlife and land management, developed in co-operation with the remote Aboriginal community of Watarru in the Anangu Pitjantjatjara Yankunytjatjara lands in Central Australia and a South Australian Government agency, the Department for Environment and Natural Resources. Its foundation and success in maintaining this unique, high area of biodiversity is underpinned by traditional land management practices working alongside western science. One of the many challenges has been in reconciling the environmental knowledge of the traditional owners with scientists, particularly in the acknowledgement and valuing of traditional practices towards the maintenance of the ecological landscape. With Indigenous land management knowledge strictly controlled and embedded within a privileged cultural framework, in contrast, science remains a knowledge paradigm that too often operates independently of values and governance models. It is further complicated when the contribution of Indigenous knowledge and its application to the environment is disregarded and considered invalid in favor of western science. The incompatibility of these two knowledge streams and their value systems present issues of critical importance for scientists managing the current environment that is rarely reconciled responsibly or effectively. This paper intends to recognize and identify the key differences and challenges that prevent the ability for Indigenous knowledge and science to be married in a healthy relationship that ensures the effective, efficient and culturally appropriate management of the environment now and for the future.

**Participatory research in forest restoration, are ecosystem functions good for monitoring?**

Lindig Cisneros, Roberto; Arnulfo Blanco-García, Berenice Díaz-Rodríguez, Mariela Gómez-Romero, Rubén Ortega-Álvarez

Centro de Investigaciones en Ecosistemas, UNAM, Mexico

Participatory research for restoring temperate vegetation in severely disturbed sites in Western Mexico have to be monitored for evaluating trajectories of restored sites and for planning new research goals. Work has been carried out mainly with the Indigenous Community of Nuevo San Juan Parangaricutiro (ICNSP) that manages its communal lands following sustainable forestry practices. Thus, restoration of severely disturbed sites has the main goal of increasing the area under sustainable management. This goal, and the nature of historical disturbances, limits the size of the restored sites. Therefore, problems of scale arise for evaluating many ecosystem functions that might be relevant for understanding the dynamics of the restoration process, but also for the certification process of the sustainable management program followed by the ICNSP. We summarize the restoration monitoring process followed in the last 10 years within the participatory research framework. From this analysis we concluded that local needs, size, and age of the restoration determine, in decreasing order of importance, which ecosystem functions can be evaluated. Finally, we propose a model for prioritizing early in the participatory research process the need for ecosystem function monitoring to better understand the dynamics of restoration and making it compatible with social needs.

**Restoration of novel ecosystems in urban areas: Ecological and social issues**

Lindig Cisneros, Roberto; Arnulfo Blanco-García, Oscar Valle-Díaz, Mariela Gómez-Romero

Centro de Investigaciones en Ecosistemas, UNAM, Mexico

Ecological restoration in urban areas is particularly challenging because site degradation is usually high and regional conditions are heavily altered. Several factors hinder restoration in urban areas, such as urban heat island effects, introduced species, isolation of remnant natural areas and conflicting social interests and values. In this presentation we present as a case study of restoration efforts in a natural protected area, Cerro del Punhuato, within the city of Morelia, the capital of the state of Michoacán in Western México. Restoration in the Cerro del Punhuato is limited by the urban heat island effect, that makes impossible to restore the original vegetation of the site. Originally, the area was covered by oak forests (Quercus spp.) and, at higher elevation, possibly by small pine populations (Pinus spp.). The heat island effect has increased mean temperatures more than 6°C, making conditions more akin to subtropical vegetation. Therefore, restoration in the Cerro del Punhuato has to create novel plant communities with species that can tolerate the present conditions of the area, hotter and dryer than in the past. Also, introduced species planted within the natural area in the past, particularly eucalyptus trees, are difficult to eradicate because of public opposition. An approach of adaptive restoration and demonstrative plots has been useful to change perceptions about what is feasible restoration in a heavily altered area of great ecological importance for the city of Morelia.

**Ten years of participatory research for conifer forest restoration in Western Mexico: Ecological and social barriers**

Lindig Cisneros, Roberto; Cuauhtémoc Saenz-Romero, Arnulfo Blanco-García, Mariela Gómez-Romero

Centro de Investigaciones en Ecosistemas, UNAM, Mexico
Ten years of participatory research for conifer forest restoration within the lands of the Indigenous Community of Nuevo San Juan Parangaricutiro allowed us to identify ecological and social barriers to restoration that interact in a complex way. Restoration focused on production systems for sustainable harvesting of timber and pine rosin. Because the restoration efforts were made on severely disturbed sites, the main barriers were of abiotic nature, related with substrate physical and chemical properties and weather variability. Later in the restoration process biotic barriers became evident such as physiological constraints of the selected plant species, seed dispersal, herbivory, and other interactions. Social barriers were related at the beginning of the project with the cultural differences between the landowners and the researchers, because, among other things, of different views of nature. Afterwards, economic and regulatory barriers became evident, in particular the need to comply with sustainable management certification. Since most of the biodiversity of Western México lies outside protected areas, its conservation will depend on incorporating more areas to sustainable management practices, and restoration of production landscapes in areas already degraded. Under this scenario, social barriers can determine what can be restored and by doing so, defining what nature will prevail.

**Controlling Bromus tectorum for shrub-steppe restoration: Responses six and seven years after treatments**

**Link, Steven; Randal W. Hill**
The Confederated Tribes of the Umatilla Indian Reservation, USA

We tested the hypothesis that the bunchgrass, _Elymus wawawaiensis_, established in 2003 will show increasing _Bromus tectorum_ control after seven years. Six years after plots that were burned, treated with Plateau herbicide at 4 or 8 oz/acre, and then drill-seed with _E. wawawaiensis_ had significantly (p = 0.0016) less _B. tectorum_ cover (14.4 ± 4.17%) than only burned plots (37.9 ± 3.65 %). In 2009, the effect remained with significantly (p = 0.0003) less _B. tectorum_ cover (19.1 ± 3.95%) in treated plots than in only burned plots (47.0 ± 3.42%). We tested the hypothesis that native species cover and richness and cover of aliens in Plateau only plots will not be different from controls after 7 years. Native species cover in Plateau only plots, was not significantly different than in controls in 2008 (p = 0.155) or 2009 (p = 0.167). Alien species cover in Plateau only plots, was not significantly different than in controls in 2008 (p = 0.061) or 2009 (0.074). Native species richness in Plateau only plots was not significantly different than in controls in 2008 (p = 0.142) or 2009 (p = 0.106). The number of _E. wawawaiensis_ plants in twelve monitored plots increased from 694 in 2004 to 946 in 2008 and 1022 in 2009. We found a strong reduction in _B. tectorum_ cover with increasing density of _E. wawawaiensis_. Sustainably reducing _B. tectorum_ cover will increase the likelihood of successful ecological restoration in the shrub-steppe.

**The role of reef restoration and active coral propagation in the recovery of declining coral reef populations and communities**

**Lirman, Diego; Chelsey Young Lahiff, Stephanie Schompeyer**
University of Miami, USA

Faced with the continued decline in condition, extent, and structure of coral reef communities, the field of coral reef restoration is gaining wider acceptance as a viable alternative for the local recovery of species and habitats. In this presentation, we will: 1) highlight the findings of a recent survey conducted among scientists and resource managers on the role that reef restoration can play on reef recovery; and 2) describe the methods presently used in the wider Caribbean for the active propagation of corals and the restoration of depleted habitats. We will also describe the successes and failures of ongoing projects aimed at restoring the threatened species _Acropora palmata_ (elkhorn coral) and _A. cervicornis_ (staghorn coral) and outline future steps to be taken towards the recovery of this keystone genus.

**Prioritizing beaches that need restoration actions from a multidisciplinary approach**

**Lithgow Serrano, Alma Debora**
Instituto de Ecología A.C., México

The state of Veracruz is located along the Mexican coast of the Gulf of Mexico. A wide array of problems such as uncontrolled urban sprawl, pollution and land use change are largely affecting the coast, resulting in biodiversity loss and degradation of ecosystem services. The beach and fore dunes are especially affected. Thus, the need to restore them is evident. However, inefficient communication, poor financial support and the lack of technical procedures pose an important obstacle to restore beaches and fore dunes. Thus, prioritizing locations that need restoration actions is fundamental. In this project we assessed and prioritized the need of restoration activities together with the...
possibility of being restored successfully in 46 beaches along the state of Veracruz. Ecological, geomorphological, social and economic criteria were considered. We were able to distinguish both, sites which need restoration actions and those that are so severely disturbed that cannot be restored, only rehabilitated. Although it is desirable to restore as many beaches as possible, human and economic resources are scarce in the region. These restricting conditions make it necessary to prioritize. Priority beaches for restoration actions were determined by a combination of tools like Analytic Hierarchy Process (AHP) and an Expert Panel. Four criteria (perturbation degree, stress, and occurrence of elements that are necessary for restoration), 12 sub-criteria and 30 indicators were considered. Our calculations revealed the beaches that need to be restored more urgently, and also, indicate where these actions are more likely to be successful.

Re-establishment of forest ecosystem services of water provision by large-scale ecological restoration in south-central Chile: An experimental approach
Little, Christian; Lara A. Antonio
Universidad Austral de Chile

Native forests of the Valdivian Rainforest Eco-region in Chile (35°- 48° S) play a key ecosystem service role in determining the quantity and quality of water supply. Previous studies in this eco-region have demonstrated the positive correlation between annual and summer streamflow with the percentage of native forest cover in the watersheds, and an opposite relationship with exotic forest plantations. These studies led to the establishment of a long-term research program to examine whether the conversion of exotic eucalypt plantations back to native forest could recover this water provision function. This experiment involves 9 small (0.9 - 123 ha) experimental watersheds located in Reserva Costera Valdiviana, proposed as a Long Term Ecosystem Research site in southern Chile (40 °S, 73.5° W). Monitoring of stream flow, nitrogen, phosphorus and suspended solids since 2006 has demonstrated significant relationships with the width of riparian strips of native vegetation, and forest cover in the watershed. In February 2011, 4 watersheds covered with plantations were cleared (total 15 hectares) and will be subjected to a passive and active restoration programs. This experiment integrates the concepts and methods of ecological restoration with ecosystem services and it will indicate the potential of large-scale restoration programs to re-establish water supply through planting native forests. This on-going, collaborative, research has important policy implications and involves several institutions, integrating social, economic and environmental dimensions in a transdisciplinary approach.

How feedback of clonal plants functions in dealing with erosion of active sand dunes
Liu, Bo
Chinese Academy of Sciences

How plant species adapt to wind erosion is an important but an unclearly elucidated issue. Erosion causes plants to fall to the ground where a plant traps a large amount of blown sand, facilitating formation of a bigger cluster. This process seems a positive feedback of clonal plants in dealing with erosion of active sand dunes. However, how it affects plant performance remains unknown. A study was conducted to examine effects of the feedback process on the growth and vegetative reproduction of two pioneering dune species Artemisia wudanica and A. halodendron. Morphological and regenerative traits of plants under different treatments as 1) no burial and erosion under upright position (control), 2) erosion under upright position (erosion treatment), 3) burial under upright position (burial treatment), and 4) erosion under upright position and then burial under horizontal position (feedback treatment) were compared. In comparison with the control treatment, the erosion treatment reduced the total biomass, but the burial and feedback treatments enhanced the total biomass. Adventitious roots and ramets were not found under the control and erosion treatments, but were found under the burial and feedback treatments. The feedback treatment had the highest total biomass, ramet biomass, adventitious root biomass and ramet growth speed among four treatments. It is concluded that the feedback process together with vegetative reproduction of clonal plants is an adaptive mechanism of psammophytes to erosion of active sand dunes.

Effects of rehabilitated forest on soil ecological function in degraded red soil region in the subtropics of China
Liu, Yuanqiu; Xiaomin Guo, Xiaohua Wei, Dekui Nniiu, Junxia Zhang, Xia Gong, Wenyuan Zhang
Jiangxi Agricultural University, China

Due to long-term irrational exploitation and utilization of soil resources, eco-environment of red soil region was destroyed intensively in the subtropics of china. Soil degradation problems, such as soil fertility decline, soil
structure deterioration, soil layer thinning, and soil moisture lack are very serious. We studied the effect of rehabilitated forest on ecological function of degraded red soil in the subtropics through the investigation of soil chemical characteristics and soil microbiota in the 20-year rehabilitated forests in different models. The results were as follows: 1) soil ecological function was improved to varying extents; 2) The effect of different rehabilitated forest types on soil chemical characteristics also varied, with the pure broadleaf plantation > mixed coniferous-broadleaf plantation > pure coniferous plantation; 3) The soil microbial characteristics of pure broad-leaved plantation was the best, that of mixed coniferous-broadleaf plantation was middle, that of coniferous pure forest was the worst; 4) The improvement of soil ecological function reduced with the soil depth in 0-40 cm.

**Regenerative strategies of psammophyte and vegetation restoration in the semiarid sand dune of China**

Liu, Zhimin
Chinese Academy of Sciences

To know how plants adapt to the active sand dune, experiencing migration and unpredictable burial and erosion, is very helpful for understanding the process of vegetation restoration in the desertified grassland. In recent years, we have conducted several investigations to get an insight into the regenerative mechanisms of psammophytes in response to eolian activities of the sand dune in the semiarid grassland of northeastern China. The regenerative strategies studied include both sexual and asexual aspects, and regenerative phenology, canopy seed bank, myxospermy, seed morphology, soil seed bank, seed germination and vegetative reproduction are taken into consideration. We found that: 1) regenerative strategies play important roles in psammophytes’ adaptation to active sand dunes; 2) regenerative feedback of psammophytes responding to eolian activities is an important aspect in elucidating psammophytes’ adaptation to sand movement by means of various regenerative strategies (as shown by *Salix gordejevii*, *Artemisia wudanica* and *Phragmites communis*); 3) psammophytes prevailed at different locations of an active sand dune might have different regenerative strategies in dealing with a same kind of eolian activity (as shown by *A. wudanica* and *Phragmites communis*); 4) psammophytes of different lifeforms have different regenerative strategies in dealing with a same kind of eolian activity (as shown by *Agriophyllums quarrosom*). Our study has led to a deep understanding of adaptive mechanisms in psammophytes in dealing with sand movement, and is important in guiding the practice of vegetation restoration in the semiarid sand dune of China.

**South Texas ecotype approach to rangeland restoration**

Lloyd Reilley, John; Forrest S. Smith
US Department of Agriculture

An initiative called South Texas Natives (STN) was initiated in August of 2000 and spearheaded by the Caesar Kleberg Wildlife Research Institute (CKWRI) at Texas A&M-Kingsville in partnership with the USDA- NRCS, E. “Kika” de la Garza Plant Materials Center. The goal of the initiative is to provide economically viable sources of native plants and seeds, and to develop effective planting strategies for the restoration of south Texas plant communities. Our guiding philosophy has been to develop ecotypic seed releases from a variety of native plant functional groups. We will discuss how the ecotypic seed release differs from cultivars and source-identified releases. We will also discuss how focusing on plant functional groups has improved our restoration efforts in exotic grass pastures.

**Disminución de los bancos de moluscos bivalvos en Venezuela: Estrategias para su restauración**

Lodeiros Seijo, César Jorge Miguel; Luis León, Oscar Hernández, Alvar Carranza, César Graziani, Robert Brumbaugh
Instituto Oceanográfico de Venezuela

Los bancos de molusco bivalvo como el árcido Arca zebra (50,000 t/año), los mejillones (*Perna perna* y *Perna viridis*), la ostra perla (*Pinctada imbricata*), la ostra de mangle (*Crassostrea rhizophorae*), el guacuco *Tivela mactroides* y el callo de hacha *Atrina seminuda*, contribuyen significativamente a la pesquería artesanal en Venezuela, con repercusiones socioeconómicas en zonas deprimidas. La sobreexplotación de estos bancos, así como eventos asociados al cambio climático han conllevado a una drástica disminución de los bancos naturales, trayendo consigo impactos negativos no solo en la actividad socioeconómica de las poblaciones, sino también en la biodiversidad de comunidades asociadas, dado el carácter de los bivalvos como bioingenieros ecosistémicos. En vista de ello, se hace imprescindible la generación de estrategias para la recuperación de los bancos naturales. Una de las estrategias, sin menoscabo de la actividad pesquera y sin interferencia con la actividad socioeconómica de las poblaciones costeras, es el uso de la acuicultura como herramienta, no solo para la producción y aumento de niveles.
The Mexican Environmental Restoration Network: REPARA
López Barrera, Fabiola; Sergio Guevara Sada
Instituto de Ecología, A.C., México

Successful ecological restoration practices need as a basis restoration ecology studies specifically developed for each region. However, the reality is that the bidirectional information flux between the restoration ecologist and the restoration practitioners is broken. In Mexico, most of the extensive restoration practices are not based on ecological studies and ecologists do not take advantage of the experience of such extensive practices. Restoration practitioners need fast accomplishments to recover degraded areas, however, restoration ecologists take long periods to publish their results in international journals and the experience is not easily transformed into specific recommendations to the restoration practitioners. Even between practitioners the restoration experiences are not always shared in the short term and the same mistakes are made in the same ecosystems in different regions. As the environmental degradation is occurring at a high temporal and spatial rate, there is a need of a link between restoration ecology science and practice and a network may be an effective tool to create it. In this talk we will show the experiences of the first Mexican restoration network (created since 2004) and the challenges and opportunities for the future of the practice of ecological restoration in México.

Ecological restoration opportunities in Mexican ecosystems
López Barrera, Fabiola; Sergio Guevara Sada, Renee González Montagut
Instituto de Ecología, A.C., México

Mexico is a highly diverse territory from both natural and cultural points of view. The country encompasses about 2 million Km2 and is among the top five countries of the world for endemism of both vascular plants and vertebrate species. However, Mexico’s unique ecosystems are threatened due to habitat loss, degradation and fragmentation, pollution, unsustainable and illegal resource use and global change. It has been estimated that 50,000 ha/year of forest (for temperate and tropical forests and scrubland only) has been lost in the period of 1976-2000. Mexico’s land use was dominated by secondary vegetation, in 2002; only 38% of the original tree vegetation cover remained; tropical forests being the most affected. The scenario is even worse if we consider that from this area, around 60 to 40% are secondary forests. As a national response, Mexico’s government has implemented reforestation programs. According to the FAO report (2010), Mexico increased from 350 000 to 3, 203 000 ha the surface dedicated to reforestation between 1990 and 2010. In this talk, we will address the challenges and opportunities to restore Mexican ecosystems using passive and active restoration. We will present a diagnosis of the practice of ecological restoration and the state of art of restoration ecology applied to Mexican ecosystems. The aspects of financial
limitations, land tenure, legislation, social organization and conflicts will be related to the challenges faced by restoration practitioners.

**Restauración ecológica de áreas degradadas del bosque de café en la cuenca del río Huehuetán**
Chiapas, México
López Martínez, Jaime; Roberto Reynoso Santos, José Luis Arellano Monterrosas
Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias, México

Se presenta la experiencia (2008-2011) de trabajo colaborativo en convenio con la CONAGUA y el INIFAP, en el proyecto “transferencia de tecnologías conservacionistas en microcuenca de la cuenca media del Río Huehuetán, Chiapas”; para superar el problema de deforestación del sistema agroecológico denominado bosque de café. Se realizó un estudio de diagnóstico y línea base de la cuenca, lo que identificó a la introducción de café Robusta y el incremento del consumo de leña como las mayores amenazas en la pérdida de la cobertura y diversidad arbórea. La erosión del suelo por escorrentía y el deslizamiento de tierra, son otros problemas asociados a la pérdida de cubierta vegetal en los cafetales. El trabajo presenta resultados de la aplicación de un esquema metodológico participativo como alternativa para restaurar el agroecosistema. El esquema comprendió dos componentes básicos: restaurar la cubierta vegetal arbórea y controlar la erosión en cárcavas. Las fases del esquema fueron: a) organización y capacitación comunitaria, b) delimitación espacial de la cubierta vegetal y ordenamiento territorial de prácticas conservacionistas, c) instalación comunitaria de viveros con especies locales, d) siembra de plantas, e) establecimiento de prácticas conservación vegetativas y f) monitoreo y evaluación de la sobrevivencia. Se crearon sociedades cooperativas, que participan en el proceso de producción de plantas forestales y para el uso en prácticas de conservación de suelos. Los resultados indican que el esquema aplicado puede ser viable para mitigar el proceso de deterioro del suelo por erosión y restaurar la cubierta arbórea en el bosque de café.

**It's not about the tree, it's about the saw**

Lounder, Barbara
Nova Scotia College of Art and Design, Canada

I make drawings by doing rubbings (frottages) of the stumps of cut trees. I have carried this out in three Canadian sites: the Banff, Alberta, the Dobson Trail in New Brunswick, and Point Pleasant Park, Halifax, Nova Scotia. The forest around Banff is a rich habitat with wildlife corridors for elk, deer, bears, cougars, and smaller mammals and birds. In the summer of 2009, trees there were thinned to prevent forest fires. Many large fires were burning in western Canada that summer, some caused by human activity, others by lightning. Even with those caused by lightning strikes, forestry practices fueled the devastation. The Dobson Trail in central New Brunswick passes through Acedian forest, one of the six great North American native forest types. A weeklong hike along the trail in the summer of 2010 took me through areas marked by pulpwood harvesting, irresponsible recreational use, and wind farm construction. Point Pleasant Park in Halifax, Nova Scotia was flattened by Hurricane Juan in September 2003. The storm devastated the coast, but this park was already in trouble. A dead forest, it suffered from poor management of the forest floor. An infestation of brown spruce longhorn beetles (via the shipping port nearby) had destroyed thousands of trees. The hurricane itself was attributed to the Atlantic being just a few degrees warmer than usual, due to climate change. Rubbings made from stumps at these three sites are the visual reminders of living trees. It takes time to make them; time to learn and reflect.

**Early growth responses of selected boreal plant species for initial reclamation using mature fine tailings and coke from the oil sands**

Luna Wolter, Gabriela; M. A. Naeth
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Mature fine tailings and coke are waste products of the oil sands industry which can potentially be used in reclamation after oil sands mining. Mature fine tailings and coke have chemical and physical properties that result from the bitumen extraction process that make these materials inhospitable for plant growth such as high concentrations of sodium, sulfate, chloride and total extractable hydrocarbons. A greenhouse study was conducted to determine whether substrates of various mixtures of mature fine tailings, tailings sand, peat mineral mix, and coke would support germination, emergence and growth of three grass species recommended for land reclamation. These grass species were ticklegrass (*Agrostis scabra* Willd.), slender wheatgrass (*Agropyron trachycaulum* (Link) Malte ex H.F. Lewis) and rocky mountain fescue (*Festuca saximontana* Rydb). Various soil and vegetation parameters were monitored so a period of 16 weeks in the greenhouse. Plant growth was inhibited in mature fine tailings and coke
Applying the diversity-invasion hypothesis to test restoration as biocontrol

Lyons, Kelly; Saber Elaydi
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Evidence from small-scale, experimental investigations suggests that species diversity is negatively correlated with colonizer success and that resident species identity can determine the strength of this interaction. In this study, we assess the applicability of the diversity-invasion hypothesis to restoration. We employed a factorial experiment in a randomized complete block design where native species richness (1, 2, 3, and 4) and composition were manipulated in 1 x 1 m² plots. At richness levels 2 and 3, we used all possible species combinations. Perennial grasses, native to Central Texas, were plugged following removal of the focal invasive KR Bluestem (Bothioclora ischaemum) using prescribed burn. Native restored species include: native big bluestem (Andropogon gerardii), Indian grass (Sorghastrum nutans), side oats grama (Bouteloua curti pendula), and little bluestem (Schizachyrium scoparium). Response variables include: cover of KR, resident, and restored species; ellipsoid area of all individuals of restored species; available soil resources; and KR and restored species phenologies. Restored species established at a rate of 70%, although establishment varied greatly among species. KR re-establishment was negatively correlated with restored species establishment success and cover and average and total ellipsoid basal area. There were also significant differences among species as determinants of KR re-establishment; however, this effect was confounded by species establishment success. Richness was not a significant determinant of KR re-establishment. Future work will focus on restored species richness x species composition effects as well as soil resource measures to assess the mechanism of competition among these species.

Restauración de áreas invadidas por el helecho Pteridium aquilinum en el sur de Quintana Roo

Macario Mendoza, Pedro Antonio
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El Pteridium aquilinum es un helecho altamente colonizador que invade las áreas de selva después de ser usadas para la agricultura tradicional. El cambio de uso de suelo de forestal a agrícola y los barbechos cortos con quemas han generado las condiciones favorables para la invasión del helecho. En Quintana Roo, se encuentran invadidas con este helecho varios miles de hectáreas y representan uno de los principales riesgos de incendios forestales. Con base en la experiencia campesina local mediante la aplicación de chapeos recurrentes para su control, en 2005 se llevó a cabo un ensayo de repoblación con caoba y cedro y “chapeos” del helecho cada 30 días, por dos años, en una superficie de una hectárea, con un control. En 2010 se realizó un muestreo en cinco parcelas circulares ubicadas aleatoriamente en ambos tratamientos, para evaluar la estructura de la cobertura vegetal. La diversidad florística y la densidad totales fueron mayores en el área repoblada y chapeada, con predominio de las especies arbóreas, individuos de talas grandes y baja densidad de helechos. En el control se registró baja diversidad y menor densidad total, con predominio de especies herbáceas anuales y con tallas pequeñas y alta densidad de helechos. Los individuos de caoba y cedro plantados presentaron baja mortalidad y buen crecimiento. La repoblación y el chapeo recurrente disminuyó considerablemente la densidad del helecho, lo cual permitió el crecimiento de los individuos plantados, el aumento de la diversidad y la densidad de las poblaciones de las diferentes especies vegetales.

Conserving wildlife in Mesoamerican pine-oak forests, with emphasis on an endangered Neotropical migrant, the golden-cheeked warbler

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The Golden-cheeked Warbler (GCWA) is a globally threatened migratory bird that winters in the also critically threatened Central American Pine-Oak Forest Ecoregion. The Ecoregion’s high diversity of pines and oaks provides habitat to a great number of threatened and endemic species. Only 25% of the Ecoregion is covered by forests and roughly 8.3% is under protection. Main threats are unsustainable forestry practices, forest fires, and extraction of forestry products. In 2003 several private and public organizations from US, Mexico, Guatemala, Honduras, El
Salvador and Nicaragua formed the Alliance for the Conservation of Mesoamerican Pine-Oak Forests, having the GCWA as a flagship species. In 2007 the Alliance developed a Conservation Plan for the Pine-Oak forests and the GCWA. Since then, the Alliance through its 14 institutional members has contributed to the conservation and sustainability of pine-oak forests, through strategic actions such as sustainable forest management, fire management, forest restoration, identification of quantitative habitat targets for conservation, GCWA and wildlife monitoring, incorporation of wildlife values into forest management, land protection, financial mechanism for forest protection, advocacy and outreach activities; all along the five Mesoamerican countries. This represents one the few initiatives born in the Neotropics that promotes sustainable management and conservation in an area of great cultural and ethnic richness, but also of high poverty rates. This demonstrates that a neotropical species, such as the GCWA can bring together the interest for priority ecosystems in the south, increasing funding, collaboration and participation. Such initiative increases benefits for the highly endangered endemic biodiversity.

**Riparian plantation for lake restoration in Bengaluru City, India**

**Madav, Ramesh; Deepak Mhatre**

Terracon Ecotech Pvt. Ltd., India

Bengaluru city was once known for its ever flourishing beautiful lakes but rapid industrialization and urbanization has taken its heavy toll resulting in degradation of drainage systems, conversion of tanks into industrial dump yards and eventually reducing the number of lakes around and within the city. A lake restoration scheme for Bengaluru city was taken up in order to revile the lake connectivity by ensuring smooth flow of water between them. To achieve this, water bodies, primary and secondary drainage networks along the periphery of the city were identified. Nearly 125 lakes and more than 180 drainage access points were studied and information regarding their current physical status was obtained through intense field surveys and secondary information. Existing plantation, surrounding land use and lake connectivity were some of the crucial factors considered during the survey. Accordingly, potential sites for plantation around the lakes and drainages were assessed and an appropriate riparian plantation scheme was suggested to help control soil erosion, reduce the damaging effects of flooding which would aid in stabilizing stream banks. Also remediating measures for improving the drainage channels were recommended. *Pongamia pinnata, Swietenia mahogony, Spathodea campanulata* and Typha grass species were recommended for large scale riparian plantation to stabilize the soil around drainages and also to improve the quality of running water by the process of filtration. This implemented strategy would aim towards up bringing of the existing lakes and drainage system and fulfill the task of lake restoration through riparian plantation.

**Tree inventory: A management tool in landscape restoration**

**Madav, Ramesh; Ashok Jain**

Terracon Ecotech Pvt. Ltd., India

The ever increasing demand for infrastructure and urbanization in developing countries has had a negative impact on bio-diversity and also poses a great threat to some of our rare and endangered tree species. A substantial amount of forest cover is lost each year due to habitat fragmentation and deforestation. In response to this, tree inventory has been utilized as an effective tool in managing the composition of urban forests and keeping a tab on plant biodiversity during the rapid urban growth. A tree inventory for a proposed National Express Highway (260 km length and 120 m wide) in India was carried out with an objective of future tree restoration in that area. This was achieved by using hi-tech handheld GPS devices in which the pin-point the location of each tree and some of their important physical attributes was entered simultaneously. ‘VrukshSharad+' a TerraconEcotech Pvt. Ltd. proprietary software was used as a tree analyzing and monitoring tool. The survey accounted for about 204,442 trees which would be directly affected in the construction phase of the proposed express highway. The composition of this tree population comprised of 152,886 *Eucalyptus globules* Labill, 20,540 by *Mangifera indica*, overlapped by 166,625 valuable medicinal trees and a few endangered species. Suitable tree restoration measures for all the affected trees, including the rare and endangered species have been advised with regards to landscape restoration and ecological development of that area.

**Benefits of a national coastal and marine habitat classification standard for prioritizing ecosystem restoration**

**Madden, Christopher J.; Rebecca J. Allee**

South Florida Water Management District, USA

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Recent events have resulted in immense data collection efforts in the Gulf of Mexico to document and evaluate the status of its numerous ecosystems. As we move toward implementing ecosystem restoration in response to the many disturbances to these ecosystems, a national standard that provides a consistent approach for classifying coastal and marine ecosystems has become indispensable. NOAA and its partners (NatureServe, U.S. Environmental Protection Agency and U.S. Geological Survey) have been working with individual scientists and managers from federal, state and regional agencies, academia, industry, and non-governmental organizations to develop the Coastal and Marine Ecological Classification Standard (CMECS). CMECS is currently being considered for adoption as the national coastal/marine standard by the United States Federal Geographic Data Committee. This paper provides an overview of the structure, development and features of CMECS, and summarizes completed and active pilot projects through summer 2011, with the goal of demonstrating the proposed standard’s applicability for inventory, assessment and restoration. CMECS builds on and integrates with existing US classification standards. The CMECS domain extends from the coastal tidal splash zone to the deep ocean, including all bottom and water column features. CMECS describes the defining features of individual habitats using five components (water column, benthic, sub-benthic, geologic and substrate). A comprehensive set of modifiers allows inclusion of additional information on environmental, structural, physical, chemical and biotic features. CMECS provides an ideal tool for organization of ecosystem and habitat data in support of assessment and prioritization for restoration projects.

The state of wetlands rehabilitation in South Africa: Lessons learned
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Water Research Commission, South Africa

South Africa, is suffering the loss of many wetlands, estimated at around 50%. In the last 17 years there has been a drastic change in environmental legislation aimed at ensuring sustainable development and wise use of natural resources, such as wetlands. Though the supportive legislation exists, the complexity of wetlands and the way rural communities in particular interact with wetlands is very complicated, hence the need for development of methods. Wetlands are viewed as a source of livelihoods in terms of goods and services they provide. In addition, the rehabilitation is by its nature a very costly initiative, as it requires different expertise, including engineers, ecologists, i.e. multi-disciplinary and resource driven. In 2002, three organizations, the Water Research Commission, South African National Biodiversity Institute (Working for Wetlands Programme) and the Department of Environmental Affairs, jointly initiated and funded a 10-year National wetlands research programme subdivided into three broad themes, one of which was focused on development of wetland rehabilitation tools. This method was prioritized over others due to the extent of wetland degradation and the fact that the already initiated rehabilitations were not based on scientific and defensible approaches. In total, eleven wetland management methods were produced. One of the key aims of the methods included provision of a standardized and a systematic approach to prioritization of wetland for rehabilitation. On field testing, these methods were found to be very useful, particularly in monitoring of the biodiversity return and costs; however, long term impacts monitoring are required.

Interaction between basal area and litter fall in forest restoration plantation
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This study aimed to evaluate the influence of basal area in litter fall in forest restoration plantation. The study was conducted in the Thermoelectric Plant Barbosa Lima Sobrinho in Seropédica, Rio de Janeiro. Seedlings of 45 species were planted between October and December 2004 at the spacing of 2.0 x 2.0 meters. In December 2006, nine litter collectors were installed and from January 2007 to December 2009 monthly collections were done and the material was taken to laboratory to be oven dried at 65°C for 48 hours, and after weighted in precision scale. One year after planting, four permanent plots of 120 m² were installed and the diameter measured annually, what was used for calculating the basal area. Mean values of basal area in 2007, 2008 and 2009 were correlated with the respective mean annual value of litter deposition. The litter fall was positively correlated with basal area (0.93, Pearson, p> 0.05). The mean values of litter fall in 2007, 2008 and 2009 were respectively 5.12, 6.60 and 6.90 Mg/ha and mean values of basal area were 18.79, 24.36, 29.72 m²/ha respectively, demonstrating that, from 3 to 5 years after planting, the growth of the plants in diameter and consequently the growth of the stand in basal area, influenced the increase in litter deposition what conducts for restoration of the nutrient cycling process.
Strategies to determine anthropogenic impacts in the partitioning of plant assemblage and biodiversity within keystone ecosystems

Marcelino, Jose; Luis Silva, Everett Weber, Patricia V. Garcia, Antonio O. Soares

University of the Azores, Portugal

The loss of biodiversity through landscape homogenization is considered to be one of the greatest threats to biological diversity. The effect of human disturbance in the partitioning of plant species diversity was assessed across a gradient of increasing anthropogenic influenced habitats in the Azores archipelago. Arborescent and Herbaceous ecosystems were monitored in five islands of the archipelago as a strategy to identify ecosystems harboring species assemblages that are at risk, and bioindicator species, requiring management strategies. Both marginal and core habitat plant assemblages were discriminated using a Species Type index. The effect of Island, Habitat Type and Habitat Core vs. Habitat Margin, for the species pool at a given habitat type, and island, was assessed. Indicator species values were determined through innovative methodology. Number of invasive and non-native indicator species were most common in the most anthropogenically influenced habitats while native and endemic species were most common in the least impacted sites. Of the 223 species observed in the forest habitats 69 species were significant indicator species and of the 189 species found in the herbaceous habitats 67 species were significant indicator species. We found that species of relevance, other than economical, are enclosed not only in natural habitats, but also in cultural habitats. An integrating approach to preserve this areas, integrating ecological data and community attitudes, may prove critical for the maintenance of these species outside remnants of natural areas, given that the minimum area for their persistence and establishment is available, and a correct management is implemented.

The successful use of engineered logs to stabilize eroding river banks

Marcus, Mickey

New England Environmental, Inc., USA

This paper discusses the successful implementation of using engineered log structures, coarse woody debris, and tree stumps to stabilize eroding river banks in Massachusetts, USA. Several case studies of projects are described, including the construction planning, and long-term post-construction monitoring. I describe over 15 completed bank restoration projects along the Connecticut River in northern Massachusetts and southern Vermont. Significant flood events (the Bankfull capacity is approximately 110,000 cfs, and spring freshet flooding is typically 65,000 cfs) are the primary cause of bank failure. Since 1995, soil bioengineering techniques have been used to stabilize eroding shorelines. In an effort to eliminate the use of stone to provide natural shoreline habitat, demonstration projects were initiated in 2009 to stabilize the eroding shoreline using engineered woody debris. In 2009, approximately 1735 linear feet of shoreline was built, and in 2010 approximately 1200 linear feet of shoreline was constructed. An additional 3,000 linear feet of work will be built over the next three years. Woody debris log jams were built at a spacing of approximately 120 feet on center and secured into the banks to anchor the planned sediment accretion formations. Native emergent and aquatic vegetation were planted between the log jams to help in the retention of sediment, and to provide wildlife and fisheries habitat. Staff gages, and scour chains were installed vertically along the project’s aquatic bench to measure accretion or deposition. To measure bank erosion, bank pins consisting of metal welding rods were installed horizontally into the banks. During the first year of monitoring, the woody debris structures accumulated as much as 30 inches of new sediment by reducing water velocity along the shoreline during flood events. There was no measured horizontal bank erosion. The accumulated sediment has permitted emergent vegetation to become established, which further protects the adjacent river banks.

Linking above and belowground dynamics in post-agricultural tropical landscapes

Marin Spiotta, Erika; A. Peyton Smith, Teri C. Bolser

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The conservation value of secondary forests growing on former agricultural lands has been traditionally underestimated. However, these emerging forests can serve important roles as habitat for biodiversity and as reservoirs of carbon in both regrowing biomass and in soils. While much work has focused on aboveground recovery, the response of belowground microbial communities and C cycling to forest regrowth is less understood. Results from a previous synthesis suggest that at a global scale, climate may be most important in explaining variability in soil C stocks in secondary forests and plantations. At the site level, other factors such as former land use, disturbance history, and plant species composition can influence the amount and direction of soil C changes. Here we report on changes in soil microbial community composition and soil C dynamics during secondary
succession on abandoned pastures in Puerto Rico. The greatest differences in microbial biomass, functional composition, and enzyme activities occur during the initial two decades of forest regrowth. Our earlier work found that key above and belowground properties also recovered in the same timeframe. Relative basal area and tree species richness matched that of primary forests in as little as 20 years, even though tree species composition remained distinct. Soil carbon mean residence time was significantly different in active pastures and 10-year old secondary forests, but after 20 years, resembled those of older forests. These data suggest that the recovery of ecosystem function may be quite rapid in post-agricultural forests.

**Restoring coastal water quality by limiting groundwater pollutant discharges**

*Marrin, D. L.*

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Water quality impacts to coastal waters (including bays and lagoons) are often related to the direct introduction of pollutants or to their transport via surface waters such as rivers. However, the subsurface or submarine discharge of contaminated groundwater into near shore environments may also constitute a source. This presentation briefly highlights several strategies that have been used to restore coastal water quality by limiting the introduction of groundwater contaminants. The repeated occurrence of algal blooms in a subtropical bay was linked to leaking septic tanks beneath the waterfront homes. The partially-submerged tanks were intercepted by shallow groundwater that flowed through highly permeable sands, thus facilitating the transport of soluble nutrients. The long-term strategy was tank replacement; however, the community also sought short-term strategies such as reactive and physical barriers. Restoring the upper reaches of a temperate coastal lagoon was complicated by the presence of residual diesel fuel that was mobilized from soils and sediments by shallow groundwater during seasonal rainfall events. Restoration strategies included minor changes to the surface soils (i.e., decreasing their permeability and restoring natural stormwater pathways) and the short-term use of bioventing to enhance aerobic biodegradation of fuel hydrocarbons. The goal was to minimize site disruption and waste generation.

**Local and Traditional Ecological Knowledge**

*Martin, Jay; Eric D. Roy, Stewart A. W. Diemont, Bruce G. Ferguson*

Ohio State University, USA

In coming years, society will be forced to adapt to lower energy levels due to projected declines in non-renewable energies. This will increase the challenge to Ecological Engineers to design sustainable ecosystems, driven by renewable energies to benefit society and the environment. This paper introduces the field of Traditional Ecological Knowledge (TEK) as an important source of ideas, inspiration and designs to help our profession meet this challenge. TEK refers to ecological knowledge and practices of indigenous and local cultures. Because these practices originated and evolved prior to the era of fossil-fuel dominance, they were designed and have continuously adapted to utilize renewable energies and resources. TEK is also well suited to sustainable design due to philosophical differences with Western science and culture. While Western culture views society as apart from and controlling ecosystems, indigenous cultures routinely see themselves as embedded within ecosystems. Because TEK has declined as the influence of Western culture has spread, there is an urgent need to identify and apply this knowledge for future benefit. Collaboration with scientists can help raise the social standing of indigenous people and of TEK within their own communities, thus contributing to cultural survival while maintaining this information. Applications of TEK relevant to ecological engineering including water management and agriculture in the Americas are highlighted.

**Indigenous ecosystem-based adaptation and community-based ecocultural restoration during rapid climate disruption: Lessons for Western restorationists**

*Martinez, Dennis*

Indigenous Peoples’ Restoration Network (SER)

This special session panel will offer restorationists a look into the Indigenous world of adaptation to climate disruption with particular focus on the role of community ecosystem management and eco(bio)cultural restoration as revealed in the international work of the Indigenous Peoples’ Biocultural Climate Change Assessment Initiative (IPCCA). Living in some of the most vulnerable ecosystems on earth, Indigenous peoples are the most impacted by climate disruption while bearing the least responsibility. With few resources and little support, they are nevertheless continuing to demonstrate resilience to change through innovation and the adaptability of traditional ecological knowledge (TEK) while collaborating where necessary with Western restoration science. We will discuss how
Western science and TEK can be complementary in ecocultural restoration and ecosystem-based adaptation; how the drivers of negative policy and economic impacts on Indigenous wellbeing and adaptive capacity, as well as already degraded ecosystems, are exacerbated by climate disruption; and the role of ecocultural indicators in identifying and measuring—both quantitatively and qualitatively—the impacts of indirect and direct drivers on ecological integrity and adaptive capacity. While Western ecological restoration is gaining ground internationally, Indigenous ecocultural restoration—the relationship of Indigous cultural viability and biodiversity—is little known. As many ecologists and restorationists are increasingly recognizing, Indigenous peoples have intergenerationally-acquired local knowledge that is important in assisting Western scientists in filling the many gaps in knowledge that will be required in the identification of ecological thresholds for restoration and ecosystem-based adaptation at multiple spatial and temporal scales.

**Uso de plantas nodrizas en establecimiento de Abies guatemalensis Rehder con fines de aprovechamiento y restauración en la parte alta de San Marcos, Guatemala**

Martínez Arévalo, José Vicente
Universidad de San Carlos, Guatemala

La restauración ecológica activa de pinabete (*Abies guatemalensis* Rehder) una especie nativa para Guatemala en alturas entre 2800 a 3400 m.s.n.m. se ha realizado empíricamente por agricultores emprendedores para procurar obtener ingresos económicos en su manejo, disminuir extracciones ilegales de ramas y ramillas en navidad y recuperar ecosistemas. Con el objetivo de conocer detalles del establecimiento de plantaciones, a través del conocimiento de agricultores sobre su entorno y de criterios de restauración ecológica, se dio seguimiento a siete sitios con parcelas de pinabete. La educación de los agricultores va desde primaria hasta diversificado. La extensión del terreno dedicada para siembra es de 0.13 a 4.50 ha, con distanciamiento 1.5m x 1.5m a 2mx2 m. Las plantas nodrizas más utilizadas son *Baccharis vaccinioides* HBK, *Buddleia megaloecephala* Donn.-Sm., *Acaena elongata* L., *Stipa ichu* (Ruiz &Pav., Kunth) y *Stevia plectaphala* Bertol., con alturas de 1 a 3 m, los árboles se han establecido de 1 a 2 m de la base del arbusto nodrizas. El porcentaje de pegue de pinabete ha sido alto con un promedio de 80%. Las plantaciones tienen en promedio 5 años de haberse establecido, en algunas ya se está haciendo aprovechamiento de ramas y ramillas, con cuál se puede concluir que a partir de los cuatro años se puede empezar a tener ingresos que van aumentando hasta un 80 a 90% de rentabilidad.

**Restauración de bosques templados: Estudio de caso El Porvenir**

Martínez García, Salvador
Comisión Nacional Forestal, México

La política del sector forestal en México tiene como objeto el Desarrollo Forestal Sustentable, que se define como el proceso que tiende a alcanzar una productividad óptima y sostenida de los recursos forestales para beneficio de la sociedad, mejorando la calidad de vida, sin afectar el equilibrio e integridad de los ecosistemas forestales. Desde que inició su operación en 2001 a la fecha el esquema de operación para la ejecución del Programa ha sufrido cambios significativos hasta llegar actualmente a trabajar bajo “Reglas de Operación” con lo cual se transparentar y hace más eficiente el uso de los recursos públicos. Para conservar y recuperar la superficie forestal del país, desde su creación la CONAFOR apoya de manera permanente y sistemática a dueños y/o poseedores de terrenos forestales para la realización de acciones de reforestación para la conservación y restauración de terrenos de vocación forestal. El Programa de Reforestación tiene entre sus atribuciones dirigir, coordinar y evaluar las acciones de forestación y reforestación, así como fomentar y promover la producción de planta de calidad para la forestación y reforestación en los ecosistemas forestales, así como la obtención de germoplasma de calidad para cubrir las necesidades de restauración forestal en el país.

**Restoration of dispersal processes in a fragmented landscape at Los Tuxtlas, Veracruz, Mexico**

Martínez Garza, Cristina; A. Guzmán-Luna, H. F. Howe
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To test effects of enrichment plantings on restoration of dispersal processes, we planted a variety of animal-dispersed trees and a comparable set of wind-dispersed species in an eroded pasture in southern Veracruz, Mexico. A 3 x 8 grid of fenced 30 X 30 m plots were located in an active pasture in 2006. Enrichment plantings resulted in an increase of richness and abundance in seed rain and tree recruitment. Vertebrate activity in plantings (bird and bat visitation and rodent residence) also increased with time. Without means of attracting dispersal agents in these fragmented landscapes, low-diversity secondary forest prevails due to long-lasting dispersal limitation of forest
species. Enrichment of early successional environments that includes many pioneer and non-pioneer species will increase diversity and complexity of regenerating forests; also, restoration plantings including variety of species will reduce failure in the face of climate change. We advocate systemic experimental manipulation in the design of large, public and commercial ecological restorations to accelerate understanding of cause and effect in community rehabilitation. Managed variation inherent to restoration designs may also be adapted to create community dynamics best able to respond to environmental change. Also, the reinforcement of public laws regarding restoration plantings after productive activities is necessary. Relevant public institutions (National Council of Forestry) should pay attention to definitions of restoration in public calls and should support the monitoring of projects outcomes.

Early growth of tree species under variable soil conditions in cattle pastures of Los Tuxtlas (Veracruz, Mexico)

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Variable soil microhabitats in restoration projects may lead to varying growth of selected tree species. To evaluate how soil traits affect early growth of seedlings in a 60-year-old pasture, we planted 1,440 seedlings of 15 native tree species in 16 30 X 30 m fenced plots in 2006. In an analysis of variance, differences in growth after 6 months resulted to be highly significant among species. At higher elevations on a range from 182 to 260 m above sea level, pH and soil density were significantly higher, whereas organic C was lower. Growth measured after the first 6 months was highly correlated with growth after 3.5 years (r = 0.66, N = 15 species). The fastest-growing species were Cécropia obtusifolia, Cojoba arborea, Ficus yoponensis, Helicarpus appendiculatus, and Platymiscium dimorphandrum. Higher pH was correlated negatively with tree growth, whereas higher concentrations of organic C, NO3, NH4, and total P were correlated positively with growth. Tree species for successful pasture restoration in Los Tuxtlas include both pioneer species (such as Helicarpus appendiculatus, Cécropia obtusifolia, and Ficus yoponensis) and non-pioneers (such as Platymiscium dimorphandrum and Cojoba arborea). The pH of areas to restore can be an important parameter to take into account for successful species selection.

Evaluation of ecological function and services in experimental restoration planting in the dry forest of Sierra de Huautla, Morelos, Mexico

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Restoration plantings are used to accelerate natural succession in degraded environments. To evaluate success of plantings to restore ecological function, we evaluated functional diversity, plant-animal interactions and ecological services from 2006 to 2011 in 8 enclosures of 50 X 50 m in a dry tropical forest in Mexico under two treatments: restoration planting of 18 native tree species (N=4) and fenced controls (N=4). Birds from all functional morphs (insectivores, frugivorous, seed eaters, nectarivorous and raptorial birds) duplicate its density by 2011 irrespective of treatment. However, already more seeds dispersed by animals than by wind have been recorded in the seed rain within plantings by 2010. Recruitment of woody species remains dominated by wind-dispersed species whereas density and richness of non-woody species reached forest levels by 2008. Ant richness increased with time irrespective of treatment whereas ant density recovered in 2007 and later decreased. In 2006, generalist myrmicine and hot climate specialists dominated, currently, tropical climate ant specialists are dominant. Low predation of seeds by Pogonomyrmex barbatus was recorded within enclosures due to higher vegetation cover. Rodent abundance and richness increased with time irrespective of treatment; rodent abundance was significantly higher in controls compared to plantations in 2008. Sigmoidon hispidus, a rodents associated to pastures was not registered in 2011. Finally, abundance and richness of amphibians and reptiles was higher in the plantings during the dry season. Some plant-animal interactions (i.e., seed dispersal and predation, pest control) have been reestablished within enclosures and have been further improved by restoration plantings.

Conserving biodiversity and ecosystem functions in successional tropical forests: Experiences from Mexico

Martínez Ramos, Miguel; Patricia Balvanera Levy, Frans Bongers
Universidad Nacional Autónoma de México

A synthesis of long-term, collaborative studies focused on exploring ecological and social factors affecting biodiversity and ecosystem functioning in successional tropical forests is presented. These studies have documented
ecological patterns, processes, and mechanisms involved in the maintenance of species diversity of plants and animals (vertebrates and some insect groups) in a wide range of secondary and old-growth forest sites. Also the studies aim to contribute to finding socio-ecological bases for the restoration, sustainable use, and conservation of successional forest ecosystems in rural landscapes. The studies are conducted in rural landscapes from the tropical rain forest regions of La Selva Lacandona (Chiapas) and Las Margaritas (Puebla), and the tropical dry forest region of Chamela, Jalisco. In these landscapes, forest cover converted to agriculture is more than 50%, mostly dedicated to cattle rising and maize cultivation. Species richness, abundance, and functional attributes of plant and animals recover depending on disturbance regimes inflicted by agriculture practices. In abandoned fields that suffered low impact agriculture (e.g., maize cultivation), species richness, abundance, and functional attributes of most studied plant and animal groups recover over a few decades, maintaining important proportions of the pool of species present in old-growth forests. In contrast, the recovery is slower in pastures, especially in those used for rising cattle for milk production. Secondary forests are becoming the dominant ecosystems over the world and conservation of biodiversity and ecosystem functioning in the tropics will depend on finding balances between socio-economic and ecological factors that may enable a sustainable management of these forests.

**Studies on restoration ecology in agricultural landscapes within the vicinity of MAB Biosphere Reserves in tropical Mexico**

**Martínez Ramos, Miguel**

Universidad Nacional Autónoma de México

Conversion to agriculture is a major disturbance suffered by tropical forests. However, the resilience of these ecosystems to such disturbances is still to be established, considering the wide range of agriculture methods and techniques used in tropical regions worldwide. Here, I show the results of a large collaborative project (Management of Tropical Forests, MABOTRO) directed to assess passive and active restoration actions useful to conserve biodiversity and ecosystem functions in agricultural landscapes surrounding two major MAB Biosphere Reserves in Mexico: Chamela-Cuixmala (tropical dry forest, in the Pacific coast of the Jalisco state) and Montes Azules (tropical rain forests in the La Selva Lacandona, Chiapas). Results of the project shows that in old fields that were under traditional agriculture, natural regeneration (passive restoration) may recover in few decades high levels of plant and vertebrate diversity and ecosystem functions but that under extensive cattle pastures, especially established on unfertile soils, active restoration are necessary to recover some level of biodiversity and ecosystem functionality. Detecting ecological and social factors which may favour multiple agriculture land use in tropical landscapes, and assessing the resilience of tropical forests to different agricultural uses are two major objectives that must be considered in the research programs pursue by MAB Reserves.

**Factors, processes, and mechanisms during ecological restoration in tropical rainforest areas of Mexico**

**Martínez Ramos, Miguel; Ximena García-Orth**

Universidad Nacional Autónoma de México

Conversion to agriculture constitutes a major disturbance in tropical rainforests. Frequently, agriculture fields are abandoned in degraded condition and passive or active restoration is needed to recover biodiversity and ecosystem functions and services. The recovery of vegetation in old fields is determined by ecological factors affecting seed rain, seed bank, germination, seedling emergence, and the survival, growth, and reproduction of established plants. Identifying the key factors that affect demographic transitions from seeds to established plants in old fields is, therefore, of paramount importance to the restoration of tropical rainforest properties in degraded, abandoned, agricultural lands. Here, we present a conceptual framework that pinpoints those factors which may act as filters or facilitators of natural regeneration, and describe the development of transplanted woody species in abandoned agricultural fields. Studies conducted in agricultural landscapes in tropical rainforest regions of Mexico are used to explore such factors, regarding different land uses and particularly cattle pastures. Among factors assessed are: matrix surrounding old fields, isolated trees within old fields, living fences, seed and seedling predation by animals, and grass competition/interference. We find that low impact agriculture and matrices with large areas covered with secondary and old-growth forest favour rapid tropical rainforest recovery through natural regeneration. The establishment of isolated, trees and living fences, protection against seed/seeding predators, and the management of grasses are key active restoration practices needed to recover biodiversity and ecosystem functions in degraded, extensive cattle pastures, and in other abandoned fields which suffered intensive agriculture land uses.
Plant reintroduction in a changing climate: Promises and perils
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Biodiversity on Earth is gravely threatened. Recent estimates indicate that one-fifth of botanical species worldwide are considered at risk of becoming extinct in the wild. The emerging impacts of climate change forebode unprecedented risk and rates of endangerment. Considered an essential worldwide conservation tool, plant reintroductions hold much promise for future conservation efforts for many rare plant species when carefully planned following guidelines and when monitored long-term. We summarize key findings of 20 years of plant reintroductions entered into the Center for Plant Conservation International Reintroduction Registry. We briefly present guidelines for planning traditional plant reintroductions vs. more controversial assisted migration options. We illustrate the process of evaluating a species and reintroduction proposals considering species characteristics and habitat needs. We contrast traditional and controversial options for two federally endangered species that have recently experienced serious population decline. We evaluate options giving special emphasis to perceptions of ecological risk and safety from climate-change related threats.

Technical and cultural challenges in the renovation of post-industrial sites
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The renovation of postindustrial sites poses special challenges, some of which are technical: such sites have usually experienced disruptive modifications. Their soil and water are often contaminated; their original flora and fauna are often gone; their topography has often been radically altered. Yet there are other, cultural, challenges as well. These sites often embody a very particular history, pose interesting design challenges, or play a unique role in the ongoing life of a community. To be successful a renovation must address both types of challenges. While the technical challenges clearly require the work of experts, the cultural challenges cannot be addressed by experts alone, requiring as well the input of the community and its various stakeholders. It would be a mistake, however, to think that they can be solved without the input of experts. At minimum landscape architects and designers will be needed. But more needs to happen for a successful renovation to take place. The historical meaning of a site is often contested and the aesthetic issues that arise in architecture (whether of buildings or landscape) require a careful conversation between experts and the various stakeholders. I propose a model for thinking about the design elements by considering the relationship between the history and the future of a site. This model suggests preserving traces of the site’s prior incarnations while developing a new use for it, a sort of acknowledging the past while looking towards the future. I illustrate this model with an example from Duisburg, Germany.

Restoring beaches for Atlantic Coast piping plovers (Charadrius melodus): A classification and regression tree analysis of nest-site selection
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To effectively restore wildlife habitat, ecological research must be easily translated into practical design criteria. Clear directives from research can support arguments that promote more appropriate restoration strategies. For the federally threatened piping plover (Charadrius melodus), beach stabilization practices often accelerate the degradation of suitable breeding habitat and could be revised to provide more advantageous conditions. Several studies of piping plover habitat selection have been conducted, yet useful and detailed design directives remain undeveloped. In this study, we use classification and regression tree analysis to (1) identify microhabitat characteristics and important interactions leading to nest establishment and (2) develop target, trigger, and threshold values for use in effective design and adaptive management piping plover habitat. We found that nests primarily occur in three distinct habitat conditions defined by percent shell and pebble cover, vegetative cover, and distance to nearest dunes and the high tide line. Nest-site characteristics vary depending on where in the landscape a nest is initiated (backshore, overwash fan, or dune). We translate these results into the following pragmatic target design parameters: (1) vegetative cover: <10% (backshore), 13% (primary dune); (2) shell/pebble cover: 17–18%; (3) dune height: ≤1.1 m; and (4) dune slope: ≤13%. We also recommend threshold values for adaptive management to maintain habitat that is attractive to plovers. This technique can be applied to many other wildlife habitat restorations. Future studies on niche parameters driving chick survival are necessary to realize the full potential of habitat restoration in increasing overall reproductive success.
Plant categorization and social consensus on plant species re-introductions

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In recent decades, plant species re-introductions have gradually integrated the field of study and experimental methods of biological scientists. These programmes often involve collaboration with other parties - particularly natural area managers and local amateur naturalists - generating networks of communication and exchange. The reintroduced plant can thus become a “boundary object”. These parties, while perhaps pursuing the same a priori goals of conservation, each hold their own personal concept of the reintroduced plant and its symbolic status. Can the heterogeneity of opinions held by scientists, amateur naturalists and natural area managers lead to a consensus on a restoration project and its management? An anthropological study based on semi-structured interviews was carried out with parties across three distinct restoration projects in France - 1) Arenaria grandiflora L. (forest habitat); Centaurea corymbosa Pourret (calcareous massif) and 3) Cistus psilosepalus Sweet (along railway track). It helped identify changes in the categorisation of plants, which at first appears as a “blurring” of the categories natural/artificial. The substitution of the categories wild/domestic into a combination of two new emerging dualisms -“spontaneous/cultivated nature” and the “local/non-local organisms”- seems to be taking place. The limits between each of these categories vary according to the frame of reference within which the parties place themselves (i.e. norms, values, scales upon which they carry out their activities…). These differences appear as a crucial point to consider in collaborative re-introduction programmes in order to satisfy the ecological as well as social requirements.

Rivers mismanagement in urban areas: The Mexico City case study

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The Basin of Mexico where the Mexico City Metropolitan Area (MCMA) is located used to be a lacustrine system with rivers flowing from the surrounding mountains. At present almost all the rivers have disappeared, have been transformed in sewers or piped. The southwestern area of the city is crucial to continue recharging the aquifer system that supplies 70% of the groundwater required by the MCMA’s more than 20 million inhabitants. Few rivers survive and represent less than 1% of the surface water supply. Maintaining the vegetation cover in this area as well as reforesting with specific species is relevant to keep ecosystem services for this Megacity. A real challenge is to recover rivers instead of transforming them in wastewater courses. An overview of the situation of the rivers in the southwestern area will be presented. The Magdalena River case showing the evolution in water quality from its source through its course until it is piped as the last river that can be rehabilitated will be discussed. Water quality as an integration of the activities that take place in the basin will be analyzed, focusing on the selection of specific relevant parameters. Potential contaminant sources will be presented and the risk they represent will be considered. This approach can be extrapolated to lotic systems in developing countries. Vegetation restoration measures as well as serious urban expansion restrictions have to be considered as urgent strategies.

Cambios en la diversidad y riqueza de especies de insectos en dos fincas de cacao sometidas a restauración pasiva

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Se utilizaron trampas Malaise para estudiar la diversidad y riqueza de especies de 7 familias de Hymenoptera parasitoides en dos fincas de cacao del estado Mérida (Venezuela), una bajo sombra plantada, donde se desarrolla la restauración pasiva, y otra de cacao agroecológico. Se comparó antes y después del inicio de la restauración pasiva. Anteriormente a la restauración se realizaron 4 periodos de muestreo de 3 semanas cada uno. Para la caracterización de la diversidad de especies se utilizaron los índices de Shannon (H’) y de riqueza (S), obteniéndose valores similares para ambas fincas. Tras año y medio de restauración se han realizado nuevos muestreos donde se observa un notable enriquecimiento de la diversidad en la finca sometida a restauración. Las curvas de acumulación de especies no alcanzaron asintotas, indicando que el esfuerzo de muestreo debe incrementarse. Los resultados sugieren que el programa de restauración, al incrementar las fuentes de alimentos y refugios, está favoreciendo la estructura de las comunidades de insectos en estas fincas de cacao.
Using payments for ecosystem services (PES) to alleviate poverty and restore degraded lands in Haiti

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Payments for ecosystem services (PES) programs are market-based tools to encourage land stewards to manage for environmental values, such as conservation and ecological restoration. By monetarily compensating land managers for environmentally responsible stewardship, PES schemes also offer a means of alleviating rural poverty, especially in developing countries where livelihoods are often directly tied to ecosystem health. Despite decades of reforestation efforts, Haiti is a country in which severe environmental degradation has perpetuated extreme poverty. To date, however, few, if any of the nearly 400 PES programs implemented in Latin America and the Caribbean over the last 15 years are located in the island nation. Through a review of past ecological restoration efforts in Haiti, we will discuss how PES programs can be designed to offer a means of filling the gaps and/or addressing failures left by these projects. A case study will outline the potential design of a PES program for use with farmers in the central plateau region of Haiti. This case, along with other examples, will demonstrate how forest-based ecosystem services may be effectively targeted by PES, and will include recommended components of such a program. We will discuss both the opportunities offered by the program as well as the obstacles to implementation in Haiti and other countries experiencing extreme poverty. We will conclude by examining issues that must be addressed in future PES programs to ensure that the rural poor around the world can participate in and benefit from growing and evolving ecosystem service markets.

Criterios para la selección de especies arbóreas para la restauración: El caso de las riberas tropicales en México

Meli, Paula; Miguel Martínez Ramos, José María Rey Benayas
Natura y Ecosistemas Mexicanos A.C.

El restablecimiento de la cobertura arbórea es una herramienta frecuente en la restauración ecológica, fundamentalmente en el caso de especies que no logran re-establecerse a partir de la restauración pasiva. La selección de especies es crítica para lograr un proyecto eficaz y optimizar los recursos. Proponemos criterios para la selección adecuada de especies arbóreas para la revegetación de riberas degradadas en la selva tropical húmeda del sureste de México. Generamos un índice de selección de especies arbóreas para priorizar la investigación y propagación de especies para la restauración. Consideramos: (1) el valor de importancia (VI) de las especies en el ecosistema de referencia, estimado a partir de censos de vegetación; (2) el potencial de regeneración natural de las especies, a partir de evidencias correlacionales en estos mismos censos; (3) la amplitud de distribución a través de diferentes tipos de hábitats; (4) el valor social y utilitario, a partir de talleres participativos con las comunidades locales; (5) los servicios ecosistémicos aportados, estimados como la tasa de captura de carbono; y (6) la factibilidad de propagación, incluyendo aspectos técnicos como la dificultad de colectar, germinar y propagar las especies. Este índice puede ser adaptado a distintos tipos de ecosistemas y a la disponibilidad de información. De esta manera puede ser corregido de manera permanente, constituyendo una herramienta útil para definir estrategias de restauración ecológica con especies arbóreas.

Importancia de la restauración ecológica en la recuperación de la biodiversidad y los servicios ecosistémicos de humedales y sistemas riparios

Meli, Paula; José María Rey Benayas, Patricia Balvanera, Miguel Martínez-Ramos
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Aunque la biodiversidad y los servicios ecosistémicos que proveen humedales y sistemas riparios son de gran importancia, su recuperación mediante la restauración ecológica no ha sido evaluada de manera sistemática. Para ello, realizamos un meta-análisis a escala global. Utilizamos una combinación de palabras clave que incluyó el tipo de ecosistema, acción de restauración y biodiversidad/servicio. Analizamos un total de 1259 observaciones procedentes de 66 trabajos en 61 sitios de estudio. Contrastamos la condición restaurada, degradada y natural de los ecosistemas utilizando el log response ratio en el programa MetaWin, en un modelo aleatorio estructurado por tipo de servicio. Los servicios ecosistémicos y la biodiversidad en ecosistemas restaurados son aproximadamente un 35% mayores que en los ecosistemas degradados. En particular, destacan los aumentos de los servicios culturales recreativos (+60%) y de regulación (+40%), en concreto la dinámica hidrológica, la erosión y fertilidad edáfica, y regulación de eventos extremos. La provisión de servicios y biodiversidad en ecosistemas restaurados es un 30%
inferior, en su conjunto, a la de los ecosistemas naturales. Aún así, los servicios culturales recreativos, la provisión de alimentos y materiales, la resistencia a especies invasoras y enfermedades, y la biodiversidad en los ecosistemas restaurados son comparables a la de los ecosistemas naturales. Concluimos que la restauración ecológica es útil para conservar la biodiversidad y recuperar la función ecosistémica dirigida al bienestar humano, pero que también es necesario preservar los ecosistemas naturales.

**Large-scale forest restoration initiatives on the ground: Lessons from the Atlantic forest of Northeastern Brazil**

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Large-scale initiatives of forest restoration are scarce around the world, including in mega-diverse, developing countries where conservation efforts are largely focused on protecting natural habitats and threatened species. Here we report a regional (a 56,000 km² area in Northeastern Brazil) experience of implementing the Atlantic Forest Restoration Pact (AFRP), which is a Brazilian initiative to promote large scale forest restoration. The first step was to survey the main stakeholders interested in restoration and assess the production and technology implementation of existing plant nurseries. Our results suggest that there is a great, and still growing, demand for forest restoration both among private and public sectors in the region, driven mainly by federal and state environmental protection laws. However, the lack of technology and insufficient seedlings production is hampering progress on the proposed targets of restoration. To solve this problem, we focused on capacity building in nursery production and landscape planning skills for land owners and government agencies. To date, universities, research institutes, and both public and private corporations of this region have subscribed to the AFRP and have adopted the restoration techniques proposed. We expect that no less than 10,000 ha of highly diverse planted native forest in Northeastern Brazilian Atlantic forest is a feasible target for the next few years. Based on our experience of implementation of the AFRP, the success of large-scale restoration projects depend on orchestrated landscape planning; capacity building for the adoption of scientific methods of planting forest and promoting the market of restoration.

**Coastal oil spills before and after the Deepwater Horizon: Integrating impact assessment with restoration.**

*Mendelssohn, Irv; Q. Lin*

Louisiana State University, Baton Rouge

The Deepwater Horizon blowout on April 20, 2010 released approximately 4.9 million barrels of crude oil into the Gulf of Mexico. Some of this oil reached coastal marshes within the Mississippi River Delta Ecosystem, which comprises almost 40% of all coastal wetlands in the 48 conterminous United States. These wetlands are of particular concern because of the suite of ecologically and economically important services they provide, not only to the northern Gulf of Mexico, but also to the nation. Ecosystem services such as hurricane and storm protection, water quality enhancement, fishery productivity, carbon sequestration, and many others depend upon healthy wetlands. We have initiated a series of field and greenhouse experiments to assess impact of the Macondo 252 spill on coastal wetland structure and function. Although this research is ongoing, we can make some general statements at this point in time. Along some oiled shorelines, where oiling was classified as heavy, oil impacts on marsh vegetation structure were severe and evident even one year after the spill. However, new plant shoots had emerged from surviving belowground rhizomes in some locations, especially for *S. alterniflora*. Ultimate vegetation recovery will likely be controlled by a number of physical, chemical and biotic factors. Restoration of impacted marshes may play an important role in remediating initial impacts and accelerating recovery.

**Overland flow as a driving force for ecological succession: Evidence from reclaimed slopes in semiarid environments**

*Merino Martín, Luis; Mariano Moreno de las Heras, Silvia Pérez-Domingo, Tiscar Espigares, José-Manuel Nicolau*

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Semiarid and arid environments are frequently structured in different vegetation patches that heterogeneously distribute water resources. The existence of hydrological heterogeneity has been studied in Mediterranean restored rilled slopes from opencast coal mining, where reclamation is especially complex because they are a special case of primary ecological succession, together with the impact of overland flow and difficulties for plant colonization. In this study, we explored ecohydrological interactions, both at the patch and the slope scales, along a gradient of
overland flow routing along the slope. We followed the TTRP (Trigger-Transfer-Reserve-Pulse) approach: 1) we compared soil moisture content in seven vegetation patches; 2) we described differences in specific ecological attributes between them; 3) we characterized ecohydrological interactions in order to find out feedback interactions; 4) we investigated the effects of overland flow on ecohydrological interrelationships. We hypothesized that: 1) soil moisture content is associated to the vegetation patch; 2) a higher soil water content is associated with a better development of vegetation and soil properties, improving vegetation performance and colonization opportunities; 3) there is an inverse relationship between the volume of overland flow routing and soil moisture content at the slope scale, influencing, in turn, hydrological processes at the patch scale. Results point out the importance of runoff routing along reclaimed slopes by distributing soil moisture and influencing the evolution of ecohydrological interrelationships and subsequent colonization by vegetation. Thus, overland flow should be included in the design of restoration projects as a key factor, as it has been described a driving force for ecological succession in these new environments.

Ecological restoration and collective action
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Management -understood as use, protection and conservation- of ecosystems generally requires collective action; that is cooperation and coordination among users, as most often ecosystems are difficult to exclude and highly sensitive to the uses and/or interventions performed by users, whether they have legally recognized use rights or not. The need of collective action is particularly high in the case of restoration as the investment of work and resources is higher than for other cases of interventions. The proposed paper presents the Institutions Analysis and Development framework, developed by Elinor Ostrom and colleagues from Indiana University, and applied through the last two decades to the analysis of diverse cases of natural resources management all over the world. This paper shows how convenient it is to apply to the analysis and planning of restoration activities.

Multi-scale study of species assemblages in a heterogeneous Mediterranean landscape
Merken, Ronny; Thanassis Sfougaris, Nico Koedam
Vrije Universiteit Brussel, Belgium

The Mediterranean region in Europe is both the cradle of ancient civilizations and a hotspot of biodiversity in the continent. Millennia of human land uses coexisted with a mosaic of semi-natural vegetation, harboring a wealth of flora and fauna. Paradoxically, recent loss of traditional and intensive land use poses a threat to these nature values while European legislation and policy demand action. Species- environment relationships are needed to guide habitat restoration and conservation of many species. This implies the use of environmental variables at multiple spatial scales, since species respond to the different habitat components at different scales. This is true in heterogeneous Mediterranean agricultural landscapes embedding protected European reserves. We evaluated the past and current evolution of eight defined landscape types through airborne and space borne imagery. Avifaunal and herpetofaunal assemblages in a Mediterranean mosaic landscape in Central Greece were related to plot and landscape level variables while confounding influences of these variables were decomposed using partial canonical correspondence analysis. Our results show that plot-level variables are good predictors of avifaunal and herpetofaunal assemblages, while landscape composition and configuration both provided independent predictive power at landscape level. Substantial joint effects of plot- and landscape-level predictors suggest that influences of these variables are dependent at multiple levels. Therefore, habitat restoration should take several organizational levels into account. Our study area is undergoing unnoticed but rapid loss of landscape elements, despite a common perception that this heterogeneous landscape is little-changed from its traditional, probably age-old form.

Growing seed banks for landscape-scale restoration
Merritt, David
Kings Park and Botanic Garden, Australia

With the increasing number of large-scale restoration programs across the globe it is common for restoration practitioners to be tackling thousands, or even tens of thousands, of hectares of degraded land. Seeds are fundamental to this large-scale restoration, being the principle means of re-introducing plants at the 100 – 1000km²-scale. But the availability of seeds of wild species is a significant challenge for restoration practitioners with many restoration programs requiring hundreds of tonnes of seed of a diverse range of species. Seed banks must play a greater role in achieving biodiverse restoration at the landscape scale. Whereas the majority of the world’s wild seed banks target
and store seed accessions that measure in the grams, or kilograms, seed banks must now re-tool to operational levels that are capable of sourcing and managing tonnes of seed. This scaling-up will require seed banks to incorporate (i) research programs that encompass and integrate the diverse themes of seed biology, ecology and technology to maximise seedling establishment and reduce the current levels of seed wastage; (ii) seed farming of wild species to address the shortfalls in seed supply and to reduce the pressures created by over-collection from wild sources; (iii) development of effective working relationships with the restoration industry and the commercial seed industry to ensure that the seed ecological knowledge generated through seed banking science is translated into the re-creation of diverse plant communities. Seed banks are well-placed to play a major role in the restoration. It is just a matter of scale.

**Situción actual de los bosques de la Amazonia Peruana, a causa de la actividad minera como principales causante de la degradación ambiental**

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La situación de los bosques en la Amazonia Peruana, actualmente está siendo afectada por las actividades insostenibles desarrolladas en todo su ámbito territorial. La actividad minera en todo el ámbito regional ha sido débilmente regulada y sin tener control alguno sobre los que extraen el recurso. Lugares como la Subcuenca Colorado: microcuenca Huiputehu-Caychive-Delta, Subcuenca Inambari, Sector del río Madre de Dios: Quebrada Huacamayo, Subcuenca Tambopata, Pampa Hermosa, Nueva Arequipa, son las zonas más ocupadas por las personas dedicadas a la actividad minera. Siendo estos lugares, actualmente explotados por el recurso oro, con uso de shute-cargadores frontales y chupaderas, dragas, entre otros; que lo único que generan es grandes impactos al bosque destruyendo no sólo su aspecto/ belleza físico sino también generando impactos sociales: la drogadicción, prostitución sexual con menores de edad, maltrato físico y psicológico, enfermedades infecciosas, gastrointestinales por el consumo de alimentos contaminados en su totalidad. Este lugar, antes era bosque, poseía gran diversidad y riqueza florística, pero ahora sólo es una zona cubierta de arena y otros metales (mercurio), que generan la contaminación de ríos cercanos, alimentos que consume la población cercana a este lugar. Diversas organizaciones del entorno fomentan iniciativas de recuperación de estas tierras degradadas por la actividad minera, en colaboración continua con el estado se ejecutan pequeños proyectos pilotos con algunos concesionarios mineros voluntariosos de contribuir al cambio y manejo de sus áreas.

**Maintaining species connectivity across a historically fragmented niche habitat**

Millar, Melissa; David J. Coates
Department of Environment and Conservation, Australia

Knowledge of genetic connectivity within species is important for informing restoration activities that aim to restore, maintain or otherwise manage patterns of gene flow across the landscape. This is especially true for species occupying historically fragmented niche habitats, for which a degree of among population genetic differentiation may be expected. The ancient Banded Ironstone Formations of Western Australia are an example of historically fragmented niche habitat. The rocky outcrops rise intermittently from the surrounding flat landscape and act as water concentrating sites in an environment characterized by unpredictable rainfall events. The inselbergs are important habitat for a diverse and highly endemic flora; however both the formations and the biodiversity they support are increasingly threatened by mining activities. Highly targeted restoration will be required for a number of short range BIF endemic taxa. Historical persistence in a naturally fragmented habitat suggests successful post-mining restoration may be best achieved by maintaining historical patterns of species connectivity. We investigated the role of gene flow and random genetic drift in maintaining connectivity in *Acacia woodmaniorum*, a critically endangered, short range BIF endemic for which post mining restoration will be required. Despite its fragmented population distribution, *A. woodmaniorum* maintains a high degree of connectivity across its range. Levels of among population genetic differentiation are limited in this taxon and levels of gene flow via pollen and or seed dispersal appear sufficient to maintain large effective population sizes. We discuss the implications of these findings for successful future post-mining restoration across the species range.

**Detailed distribution modelling of two, narrow-endemic, rare plant species threatened by mining identifies attributes of sites necessary for their restoration**

Miller, Ben
Kings Park and Botanic Gardens, Australia
Species distributions result from evolutionary, ecological and historical processes operating across spatial and temporal scales. Modeling the distribution of rare plant species can help to identify factors limiting their distribution, as well as likely sites for survey for new populations, the location and attributes of ideal sites for translocation programs, and environmental requirements for restoration sites. It can also give valuable insights into species interactions with disturbance regimes and threats, and provide specific testable hypotheses in relation to environmental interactions and limitations. The distributions of the shrub *Darwinia masonii* (Myrtaceae) and the sedge *Lepidosperma gibsonii* (Cyperaceae) using MaxEnt models based on >900 presence records per species, together with environmental data on geology, fire history, aspect, solar radiation receipt, slope, slope curvature and elevation over 96 km² surrounding the distribution of both species. Both species are declared-rare-flora, endemic to the region of a single Banded Iron Formation (BIF) range in the semi-arid SW of Western Australia. Both distributions are impacted by iron-ore mining, and miners are required to invest in programs devoted to their restoration. Modeling results identify differences in the environmental interactions of the two co-occurring species, describe environmental parameters limiting growth for one species and provide insights into the ecological requirements of both - including differing degrees of niche occupancy and fire-disturbance resilience. These results provide clear detail on differing requirements for restoration and differing strategies and likelihoods of success for translocation programs.

**What role for ecological restoration in addressing broad-scale conservation challenges?**

**Miller, Jim**

University of Illinois, USA

Ecological restoration has become a widely adopted conservation strategy. Yet restoration fails as a conservation ideal to the extent that it is motivated by asking “what was here before and how can we re-create it?” Putting aside questions about the prospects for attaining such a goal in an age characterized by climate change and novel ecosystems, there is a fundamental mismatch in spatial scale between our most pressing conservation issues and this form of restoration. Ecosystem re-creation is typically limited to relatively small areas, constrained by logistics and expense. Issues such as biodiversity conservation, provision of ecosystem services, and enhancing the resilience of social-ecological systems must be addressed over much broader scales. Further, ecosystem re-creation results in restored areas that are divorced from their surroundings, reinforcing a sense of otherness from the places where people live and work. This isolation conflicts with a growing recognition that effective conservation efforts must extend beyond protected areas to include the working landscapes in which they are embedded. Under this paradigm, ecological restoration must be motivated by asking “what is here now and what is possible in the future?” Ultimately, landscape context will dictate what is possible. Broad-scale restoration will require a certain level of ecological potential in the landscape as well as social readiness. I illustrate these points by drawing on examples from restoration efforts in the tallgrass ecoregion of the central U.S.

**Planning the ecological restoration of semi-arid agricultural watersheds through the assessment of ecosystem services**

**Miranda Mojica**, Beatriz Teresa; F. A. Comín, R. Sorando, S. Molinero, A. Calvo, V. Anzalone

Universidad La Gran Colombia, Spain

The assessment of ecosystem services can be a useful methodology to define restoration actions at watershed scale. River Piedra (a 76 km long river in NE Spain, watershed 1.545 km²), lacks typical riparian habitats and water quality because of intensive land-use for agriculture in its watershed. The assessment of ecosystem services using direct indicators (soil structure, mineral and organic contents, plant cover and habitat use for conservation, recreation, food and mineral production) and indirect estimates (gas and climate regulation, water runoff and soil erosion), applied to environmental units defined for the whole watershed (based on habitat types and land use) and the river (based on slope and riverside plant cover) using GIS (Geographic Information System) identified major actions for restoration: a program for the abandonment of agricultural lands where soil erosion and water runoff is high and stimulating soil conservation and low fertilization agricultural practices; restoring degraded bush and forests with native plant communities; habitat diversification in the river bed by removing fine sediment, and providing shade through riverside forest plantation after widening the riverside through agreements with land owners. A multi-criteria analysis using expert inputs was used to normalize the values of different ecosystem services, obtain an aggregated value and establish priorities for restoration actions distributed hierarchically in the watershed. Finally, using the GIS system evaluations of the ecological improvements achievable under different restoration scenarios were obtained. This methodology can be useful to apply ecological restoration as a tool for the development of degraded agricultural watersheds.
Designing and evaluating ecological restoration in biodiversity offset schemes: A consultant and Business & Biodiversity Offsets Program (BBOP) Assurance Working Group members’ perspective

Mitchell, Robin
Golder Associates, New Zealand

Biodiversity offsets, whether as part of regulatory tools, or, of market mechanisms, are a strategy towards a sustainable development; they are currently in global use and in a process of evolution. Biodiversity offsets encompass an environmental compensation vision where, following good faith and scientific rigor, the ‘No-Net-Loss’ goal founds a set of precautionary design objectives. Under both the 2011 draft International Finance Corporation (IFC) Performance Standards, and, the multi-sectoral Business and Biodiversity Offsets Program (BBOP) auditing framework currently out for public consultation, offset goals may or may not include restoration goals - according to which of two possible strategies are chosen. The strategies are either to ‘avert loss’ - where confidently foreseen to occur within the near future in the absence of an offset protection initiative, or, to undertake an ecological restoration program that aims to create sufficient ‘condition gain’ to offset the loss. Both of these strategies require careful attention to a value apportionment upon biodiversity components and/or ecosystem services that allows an appropriate ‘trade’ of loss for a banked or anticipated gain. It is also imperative that any offset is agreed fairly by all stakeholders with significant interests in local/regional/global biodiversity conservation, defined according to the scale of losses. When designing offsets, robust restoration ecology based tools are vital to reduce risk of permanent loss, and so, of unsustainable outcomes. In this talk, current case studies from New Zealand and Indonesia are used to illustrate the perspective of a consultant and BBOP Assurance Working Group member.

An integrating framework for mangrove rehabilitation in Sepetiba Bay, Rio de Janeiro, Brazil: A case study on reducing forest fragmentation and edge effects

Mochel, Flavia; Carolina P. R. da Silva, Udo Gebrath Jr., Marcelo G. da Silva, Diego Fernandes, Fabio S. Gonçalves, Vanessa R. Machado
Universidade Federal do Maranhão, Brazil

Mangroves are valuable coastal ecosystems but they face great damages and losses due to human activities of urban and industrial expansion. In the tropics, including Brazil, mangrove ecosystems are under constant threat from land reclamation, clearing, draining, and infilling as part of planned or unplanned development. An effort to restore a 1.3 ha area of mangroves has been made in Sepetiba Bay which concentrates most remaining mangroves of Rio de Janeiro as well as large industrial enterprises and an expanding urban area. The deforestation of a mangrove forest led to habitat fragmentation, edge effects and dynamic changes in mixed stands of Rhizophora mangle, Avicennia schauermaniana and Laguncularia racemosa. Methods accomplished an integrated framework, baseline ecological information, with oceanographic, climatic, geochemical and biological parameters, as well careful site and species management and monitoring. The results presented for 4 years, from January 2008 to January, 2011 show that herbivory was successfully controlled by spraying sites with 20 % seawater, for preventing insects, and introducing vegetal matter from fallen trees to feed crabs to prevent seedling predation. Mortality of seedlings and young plants varied from 3% under normal environment conditions to 10% or more after blooms of Lepidoptera larvae. After 4 years of restoration activities maximum tree height achieved 7.0 meters and minimum tree height was 1.5 meters in the most impacted sites. The integrated framework and the multiplicity of parameters involved in the methodology were mostly responsible to the large success the mangrove restoration has met.

Restoration of tropical forests disturbed by mining in Bonai-Keonjhar Iron Ore Belt, Odisha (India)

Mohanty, Braja Narayan
Institute of Wood Science and Technology, India

Over last nine decades the tropical deciduous forests of North Odisha State (India) comprising dominant species like Shore arobusa, Terminalia tomentosa, Anogeissus latifolia, etc. are getting honeycombed and the forest ecosystem profoundly disturbed due to open-cast mining of iron and manganese ores. Because of severe ecological constraints introduced by mining operations, left to nature the autochthonous forest succession probably may take thousands of years to restore the original forest composition in mined out areas. However, in course of extensive phytosociological surveys in the mining affected undisturbed, semi-disturbed and disturbed forest areas it was brought out that re-establishment of native vegetation in specific mines which were abandoned over last forty years are quite encouraging as opposed to the rest of the cases where revegetation was rather poor. The ecological factors viz. frequency, density, abundance and basal area of regenerated plants in abandoned mine sites vis-à-vis that in nearby
natural forest of three horizontal classes were investigated. Basing on the ecological success of species in different disturbance regimes found out through Importance Value Indices, the pioneer and mid-successional species were brought out. The distance of forest edge and the age of abandonment of mines were correlated with revegetation pattern in abandoned mine sites. Inferences about revegetation possibilities were drawn on the basis of fluxes and influences operating in the area. The prospects to replicate forest succession and to accelerate it through improved reclamation practices have been explored.

**Costras biológicas en la restauración de ecosistemas de pastizales en el altiplano del Noreste de México**

**Molina Guerra, Víctor Manuel; Marisela Pando Moreno, Enrique Jurado, Israel Cantú Silva, Eduardo Estrada Castillón, Joel Flores Rivas**

Facultad de Ciencias Forestales, México

Los pastizales naturales del norte de México son el refugio de un alto número de especies endémicas; además, influyen en el clima a nivel regional, albedo, recarga de acuíferos y almacenamiento de carbono. Sin embargo, estos ecosistemas suelen verse afectados por la escasez de agua y altos índices de erosión, que limitan el establecimiento de la vegetación. Las costras biológicas del suelo (CBS) pueden contribuir a la retención del suelo y a la disminución de la evaporación. Considerando el panorama general de los pastizales mexicanos y su importancia ecológica como ecosistema y fuente única de endemismos, se realizó esta investigación, identificando y caracterizando las CBS presentes en los pastizales del altiplano del norte de México. Además, se determinó la relación existente entre los tipos de CBS y las condiciones bióticas (vegetación y suelo) y abióticas (pendiente y altitud) donde se desarrollan. Los resultados preliminares muestran que, por ejemplo, *Nostoc commune* y *Psora crenata* se encuentran en suelos con altos contenidos de carbonatos de calcio. El conocimiento de las condiciones edáficas, pendiente, altitud y vegetación asociada que requiere cada tipo de CBS es premisa indispensable de llegar a plantearse una restauración de las áreas utilizando costras biológicas.

**Model communities and network approaches to restoration**

**Montoya, Daniel**

University of Bristol, UK

The session presented here aims at discussing the need to integrate empirical knowledge and theoretical aspects in the science of ecological restoration, and how theoretical models and network approaches can overcome some of these traditional limitations. In particular, network theory provides a framework to understand structure and dynamics of degraded and restored communities. The main goal is to generate ideas and integrate different fields (theoretical models, ecological networks, biodiversity-ecosystem functioning, etc) into the field of ecological restoration. By outlining examples, this session aims at covering new frontiers in restoration ecology such as landscape restoration and the concept of functionally important species, and identifying areas where models are needed.

**Probabilidades de restauración del Humedal Laguna del Miedo, Yondó, Antioquia-Colombia**

**Montoya Rendón, Andrés Felipe; Nelson Enrique Gil Patiño, Fabio León García Barrios, Saúl Moreno**

Universidad Católica de Oriente, Colombia

En el año 2010, se evaluó el Humedal Laguna del Miedo, en Colombia, empleando métodos de restauración ecológica, con el fin de resolver la hipótesis de que: "Aún siendo la oferta ambiental y el potencial biótico viables, las probabilidades de tener un potencial de restauración positivo para este humedal, están sujetas a si el potencial sociodinámico representado por la Comunidad, Administración Municipal y Ecopetrol puedan lograr llegar a un acuerdo para mantener este ecosistema funcional en el paisaje". Los resultados indican que una serie de diques construidos por Ecopetrol, han aislado superficialmente el Humedal del río Magdalena, ocasionando una disminución del caudal disponible para la laguna, se impide el ingreso de sedimentos, la hidráulica interna se ha modificado, la migración de peces rofílicos presenta una interrupción y un aislamiento geográfico parcial, su fragmentación induce una desconexión paisajística del complejo a nivel regional, y la disponibilidad de agua potable para el área urbana decrece. Bajo este escenario el ecosistema se encuentra en un estado de deterioro, y emprender alguna actividad de rehabilitación en este humedal, presenta una probabilidad del 40% cuando se calcula el Potencial de Restauración, lo cual está sujeto a que con una comunidad poco conocedora del problema, a la vez se resuelva el conflicto por el uso actual del agua entre el municipio y Ecopetrol, quién antepone el progreso económico del país.
 Debido a que la sobrevivencia de *P. quinata* en la zona de banco y bajo de Caparo es baja. Se inocularon plántulas con HMA nativos provenientes de la zona del banco: IBAN, del bajo: IBAJ, *Glomus manihotis*: GM como especie introducida, el suelo nativo: SNE y el control suelo estéril: C. A los 300 y 600 días después de la siembra (DDS) se evaluó la sobrevivencia, la tasa de crecimiento relativa (TCR), actividad fotoquímica y bioquímica. Los resultados mostraron que las plantas inoculadas obtuvieron porcentajes de sobrevivencia (> 95%), a diferencia del tratamiento SNE (3%) y las plantas C que no sobrevivieron a los 300 DDS. Las plantas cultivadas en el SNE presentaron valores negativos en la TCR, incluso en la zona del banco. La actividad fotoquímica de las plantas inoculadas con HMA nativos y GM se encontró relacionada a los incrementos en los contenidos de clorofila, proteína soluble total, mientras que la disminución de la eficiencia cuántica relativa del fotosistema II (ΦPSII), transporte de electrones (J) y el coeficiente de extinción fotoquímica (qP) en los tratamientos de la zona de bajo, especialmente el SNE nos permite señalar que existe una regulación descendente del aparato fotoquímico paralela a la actividad fotosintética y al grado de la inundación en la zona de bajo. El uso de inóculos nativos e introducidos nos permite garantizar la sobrevivencia, crecimiento y actividad fotoquímica y bioquímica de *P. quinata* cuando es trasplantada a las condiciones naturales del bosque biestacional de Caparo.

**Wetland restoration in a protected area: Ecological and social impacts**

*M. Casasola, Patricia; Hugo López Rosas, Fabiola López Barrera, Verónica E. Espejel González, Lorena Sánchez Higueredo, Judith Vázquez*

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A restoration project started in 2007 in a site (originally covered by a tropical marsh) invaded by Antelope grass (*Echinochloa pyramidalis*), an African grass species commonly introduced in Mexican wetlands due to its tolerance to flooding and is now a widespread invasive species. The objectives were: a) eliminate the invading grass, b) increase the native vegetation, and c) recover habitat for waterfowl. Artificially, we manipulated the hydroperiod to increase the inundation period. Monitoring plots were established and several techniques were applied along the site. After two years, the relative importance of *E. pyramidalis* decreased almost 10 times in comparison with its original cover (from 0.34 ± 0.05 in 2007 to 0.03 ± 0.01 in 2009) and after four years was almost completely eliminated, remaining only in one control set. However, during 2009 (a dry year), *E. pyramidalis* resprouted in the higher parts of the site. Native species such as *Sagittaria lancifolia*, *Pontederia sagittata* and *Typha domingensis* increased their cover values along the site. Although the restoration objectives were achieved, the temporal and spatial variation in the dominance of *E. pyramidalis* highlights the importance of long-term monitoring. Restoration has been achieved through dedicated manual labor provided by young local farmers. They have become thoroughly involved in the project and their observations of local processes have contributed to implement the adaptive management scheme and a local ecotourism project has incorporated the visit to restoration wetland as part of their field visits.

**Are we restoring wetlands?**

*M. Mateos, David; Mary E. Power, Francisco A. Comin, Roxana Yockteng*

*University of California, Berkeley*

Half of the world’s wetlands have been lost over the last century. Wetland restoration to recover critical goods and services has been widely attempted, but the degree of actual recovery of wetland functioning and structure from these efforts remains uncertain. Our results from a meta-analysis of 654 wetland sites show even a century after restoration efforts, biological structure and biogeochemical functioning remained on average 30% lower than in reference wetlands. Either recovery has been very slow, or post-disturbance systems have moved towards alternative states that differ from reference conditions. We found more rapid recovery when large wetland areas (>100 ha) were restored; when restoration occurred in warm (temperate and tropical) climates; or when restored sites experienced more (riverine and tidal) hydrologic exchange. Because restoration success is limited, the policy of using restoration attempts as mitigation offsets to justify further degradation is leading to a global loss of wetland function and structure. Comparing wetland recovery trajectories under different conditions may shed light on factors that impede or facilitate restoration.
Elevation and redox potential as controls on vegetation development of restored salt marshes

Mossman, Hannah; Anthony J. Davy, Alastair Grant
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Salt marshes reactivated by dike breach often show persistent differences in vegetation compared to natural reference marshes. In Britain, a number of important species tend to be absent from such restored marshes, even after many decades, leading to depauperate communities. These marshes frequently have an elevation range comparable with that of reference marshes, but inferior drainage. We have investigated the roles of propagule availability and abiotic factors in controlling colonization, using field surveys, and field and laboratory experimentation. Field surveys have shown that, although they are correlated, elevation in the tidal range and sediment redox potential have independent, distinctive effects on Salicornia europaea, Suaeda maritima, Aster tripolium, Limonium vulgare, Triglochin maritima, Plantago maritima, Armeria maritima and Atriplex portulacoides. Field experiments in which elevation was manipulated by ±15 cm have revealed that microtopography has large effects on sediment redox potential and both the survival of transplanted individuals and natural colonization from propagules. Glasshouse experiments with five key species deficient in restored marshes have shown substantial variation in their tolerances of low redox potentials generated by waterlogging treatments. Even where restoration sites occupy generally appropriate elevation ranges within the tidal frame, variation in microtopography and local drainage conditions may lead to poor colonization of species characteristic of a mature marsh. This constraint is largely associated with poor oxygenation of the sediments and the attendant problems of ion toxicity. We present recommendations for the management of microtopography in restored salt marshes.

Twenty five years of forest restoration in the city of Rio de Janeiro: Results and perspectives

Moura, Ciro José Ribeiro; Luiz Carlos Busato, Paulo Ricardo Gobbo, Adriano Arruda, Claudio Alexandre de Aquino Santana
Signus Vitae, Brazil

Challenges regarding forest restoration have evolved since the 19th century plantings of Major Archer to reestablish water supply of Rio de Janeiro. To date restoration has got multiple targets: prevent the expansion of irregular occupation, avoid erosion and soil slides, improve landscape, fix carbon, restore forest environments and reestablish connectivity. Mutirão Project lead initiatives at Rio de Janeiro since 1986, with the strategy of engaging local communities as work force for restoration. This study analyses the project after 25 years, based on investigations at 75 plots. 2789 trees of 128 species were sampled. The average volume is 17.43 m³/ha, representing 3.99 ton of stored carbon/ha. Mimosa caesalpinifolia, Gochnatia polymorpha, Schinus terebinthifolius and Clitoria fairchildiana are the most abundant species. The native species correspond to 70% of total, divided into pioneers (52%), early-secondary (18%), late-secondary (19%) and non-classified (11%). There is a weak correlation (R²=0.1647) between classes of successional advance and time. The results suggest that succession is strongly influenced by fires, grazing and diseases. Mutirão showed to be effective as “natural barrier” against irregular occupation, and provides carbon fixation and tree cover of the city hills. However, the authors suggest some adaptation in Mutirão Project: (1) a review of implementation techniques based upon best results and other positive references; and (2) evolve from a “work force” to an “environmental service” initiative, rewarding communities with best restoration results. A consistent monitoring program must be part of the project initiatives.

Relationship between the density of two potential restoration trees and species abundance and richness in a degraded afromontane forest

Mullah, Collins Jared; Kari Klandrud, OrjanTøtland, Bernard Kigomo
Norwegian University of Life Sciences

The high-mountain forests of East Africa are currently degraded and subject to extensive burning and livestock grazing, which result in large changes in forest characteristics and may hamper natural recovery. Efforts have been made to restore these forests by active restoration using indigenous tree species. However, little is known about how species used for restoration actually influence other species in the degraded afromontane forests. In this study, two pioneer tree species; Albizia gummifera and Neoboutonia macrocalyx that commonly occur in degraded afromontane forest throughout East Africa are investigated with regard to the relationship between their density and the density and richness of other species. The study was conducted in a degraded forest consisting of disturbed transition zones and secondary forest in Mau forest, Kenya. Our results show positive relationships between the density of Albizia and the abundance of tree seedling and sapling richness in the transition zones and in the secondary forest. Shrub richness was negatively related to the density of Albizia. Abundance and richness of tree saplings and shrubs were
positively related to *Neoboutonia* density in both the transition zones and in the secondary forest. Herb species richness declined with *Neoboutonia* density in the transition zones but increased with *Neoboutonia* abundance in the secondary forest. Since it appears that the two species positively influence the abundance and species richness of other woody species, our results suggest that both species can be suitable for active restoration of degraded mountain forests within their natural range.

**Criteria for evaluating rehabilitation success in post-mining landscapes**

**Mulligan, David**  
University of Queensland, Australia

Among the factors that have led to the development of policies around mining and the environment is the recognition that (1) mining is a temporary form of land use; (2) at the completion of mining there are opportunities for the land to be rehabilitated to one or more post-mining land uses; (3) there has been an expansion in the rate of development of new mines and increased production at existing mines in recent times; and (4) there is an increasing expectation by communities about the degree to which environmental and social values are to be protected from mining impacts. These factors have focused the attention of regulators on mine rehabilitation. As an example from Australia, Queensland legislation requires mining projects to have an environmental management plan that states the objectives for rehabilitation as well as measurable indicators and completion criteria that are to be achieved. Rehabilitation objectives must provide a description of proposed outcomes and identify post-mining land uses that are acceptable to the community and government. Rehabilitation indicators provide defensible measurements of progress towards the rehabilitation objectives. Rehabilitation completion criteria must provide a definition of successful rehabilitation at the mine site in the form of measurable benchmarks against which the rehabilitation indicators can be compared to determine whether the objectives are being met. This presentation provides examples of approaches that mining operations have used to measure whether the processes and procedures implemented will ultimately lead to a successful and sustainable outcome that will be acceptable to society.

**Assessing impacts on Ktunaxa Nation cultural resources from timber harvest and prescribed burning, southeastern British Columbia, Canada**

**Munson, Thomas**  
City of Victoria, Canada

Timber harvest and prescribed burning in the Rocky Mountain Trench in southeastern British Columbia are part of long-term ecological restoration in the forest and grassland ecosystems of the region. Conducted in the traditional territory of the Ktunaxa Nation, this restoration work has the potential to impact Ktunaxa prehistoric archaeological sites around kettle lakes in the Trench. The focus of this research project was the integration of cultural information into ecological restoration decision-making processes. Background literature research was completed on impacts of fire on cultural artifacts. Detailed inventory of archaeological sites was completed using standard archaeological site inventory procedures; inventory information served as baseline data prior to monitoring of timber harvest activities around the cultural sites, done under prescribed winter conditions of frozen ground and snow cover. Surface soil disturbance surveys were completed around the sites following timber harvest activities, to assess impacts to Ktunaxa cultural sites. Management recommendations are provided for reduction of impacts of timber harvest equipment and prescribed fire on cultural sites. These include timber harvest only under prescribed winter conditions, use of low impact harvest equipment, exclusion of equipment from ecologically and culturally sensitive sites, and training of field staff in identification and protection of cultural sites. Ktunaxa Nation natural resources staff must be involved in all aspects of ecological restoration planning to fully protect cultural resource values. Ecological restoration activities will be complemented by successful integration of Ktunaxa cultural information and values into restoration practices.

**Best practice in restoration: Different circumstances, different principles?**

**Murcia, Carolina**  
Fundacion EcoAndina, Colombia

IUCN’s World Commission on Protected Areas initiative to produce best practice guidance to the global restoration and protected area management community is a step in the right direction. IUCN has selected two leading institutions to guide this effort. Yet, it is a challenging task as the group attempts to reconcile rigor and specificity in the directives in the midst of the incredible diversity that embeds protected areas worldwide. The first challenge is to constitute a working group that is representative of different points of view (cultural, academic, institutional, etc.), but not too disparate that makes it hard to reach a consensus. The second is to wordsmith a document with language...
that is clear and specific, but not too restrictive to not accommodate all possible circumstances. The third is to gauge how far to advance a document before submitting it for wide review, without restricting the options for revision and redirecting the focus. Ecological restoration is a site-specific activity, affected on a case-by-case basis by the site’s circumstances and history, a myriad of combinations that makes generalization almost impossible. Can we draw general, broad principles that are applicable to protected area managers across the planet, from lower to higher latitudes, from Asia to America? Perhaps not, yet the discussions that are taking place as a result of this exercise are illuminating our own shortcomings on understanding what it is that we wish to restore, and thus are likely to help us better restore our protected areas.

**How to apply science to restoration: Challenges for Latin American academics and practitioners**

**Murcia, Carolina**  
Fundacion EcoAndina, Colombia

The absence of scientific bases on decision making is a permanent concern of environmental managers and conservationists worldwide. It is most worrisome in Latin America given its megadiversity and the paucity of information to manage it. Science provides rigor and supervision, but also the framework and knowledge that allow restoration practitioners to design strategies, considering ecological models and response rules. It also provides causal structure and predictive power to understand the consequences of different options. To apply science to restoration, academics and practitioners need to find a common ground, and that takes more than just finding the time to sit both parties at a table, or giving lectures to practitioners. In addition, current models of rewards and demands on practitioners and academics in Latin America are driving a deeper wedge between the two groups. Following a developed-world academic model and culture, there is increased pressure for research that, rather than answer site-specific issues, demands that questions address broader and cutting-edge issues. Restoration requires mostly local natural history knowledge and site-specific answers, none of which give international fame and glory. What needs to change? How research questions are formulated, how practitioners and managers perceive scientists and science, and the role of civil society. There is also need for new and specialized mechanisms of communication that do not demand additional time from academics and practitioners. We propose a new strategy on how to bridge this information gap, a professional profile that serves both groups, and encourage a new interdisciplinary training to generate such professionals.

**Restoring biodiversity and ecosystem functions with ecological restoration projects**

**Naeeem, Shahid**  
Columbia University, USA

Neither biodiversity nor ecosystems exist independent of one another and this creates challenges for management, conservation, and restoration that focuses on only one or the other. Recent advances in trait-based environmental biology, however, provide a number of ways of addressing these challenges. I will present three examples of the utility of trait-based approaches; (1) quantifying biodiversity as it relates to ecosystem function, (2) quantifying ecological capacity, and (3) assessing the biological insurance value of rare species. I will argue, from these examples, that functional diversity is more important to restoration than taxonomic diversity. Key to these approaches is understanding how ecological complementarity, compensation, and redundancy are related to one another and what they tell us about functional diversity.

**Local mapping of ecosystem services: Merits and challenges**

**Nahuelhual, Laura; A. Carmonas, G.I. Diaz**  
Universidad Austral de Chile

Fine scale mapping of ecosystem services (ES) has received little attention and requires innovative new methods. We propose a methodological framework and discuss its merits and challenges. We conclude that any framework for local mapping must account for the hierarchy of spatial scales: at the farm level, site conditions, management decisions, and family cycles, interact to determine the ES flows that will translate into economic benefits over time and space; the ecosystem scale provides the basis for the assessment of stock and potential flows of ES; at the landscape scale, multifunctionality requires understanding the interactions between ES and it is at the center of trade-off analysis, whereas landscape fragmentation constrains the spatial continuity of ES flows; the territorial scale comprises institutional decisions (e.g. public and private investment) which determine how ES are finally translated into economic benefits. The main merits of the approach are: a better representation of the influence of landscape processes on ES; an easier assessment of hierarchical relations, especially when spatial boundaries are available (e.g.
farm boundaries); and the incorporation of sustainability criteria by estimating and valuing only sustainable flows. Main challenges emerging from the need to generate spatial variability in stocks, flows and values are: the need to combine information from different sources, scales, and resolutions; higher risk of double counting ES; the need for strong assumptions regarding relationships between stock, flows, and values, especially in the case of cultural services for which these concepts are difficult to represent spatially.

**Regrowth forests on abandoned agricultural land: Spatio-temporal dynamics, drivers and implications for ecosystem services**

**Nahuelhual, Laura; G.I. Díaz**

Universidad Austral de Chile

Regrowth forests on abandoned agricultural land can contribute to the recovery of ecosystem services. We analyze the spatio-temporal dynamics of forest regrowth between 1985 and 2007, identify its biophysical and socioeconomic drivers at the farm level using a spatially-explicit model, and use the model to assess its probability distribution under different policy scenarios. The study area is a multifunctional and highly dynamic landscape in Chiloé Island, southern Chile. Land cover data came from two Landsat scenes taken in 1985 and 2007. Farm level information came from census data and a spatially-explicit typology of farming systems. The results from the spatio-temporal analysis show that agricultural land decreased from 30,061 ha in 1985 (17% of the landscape) to only 16,518 ha (10% of the landscape). Significant drivers of forest regrowth were soil quality, distance to secondary roads, distance to aquaculture production centers, distance to natural reserves, and the existence of farm subsidies. The two evaluated scenarios were: i) increased farm subsidies (from 154 to 1,139 farms); and ii) more protected areas (new coastal area of 8,835 ha). Under the first scenario, the percentage of farms that experienced forest regrowth decreased from 58% (status quo) to 35% thus compromising the potential recovery of ecosystem services. Under the second scenario the number of farms that experienced forest regrowth increased from 58% to 90%. The results confirm the challenge of enhancing ecosystem services recovery in multifunctional landscapes, with diverse decision makers distributed all across the territory and responding to mixed incentives.

**Estimating the non-market costs and benefits of dryland forest landscape restoration in Central Chile**

**Nahuelhual, Laura; Ignacio Schiapaccasse, Felipe Vásquez, Cristian Echeverría**

Universidad Austral de Chile

The expansion of agriculture and urban areas has led to a loss and degradation of dryland forest in central Chile. Between 1976 and 2008, 42% of dryland forests have disappeared. Estimating the Net Present Value (NPV) of restoration interventions is relevant to orient decision making towards public and private restoration. Our goal was to estimate the benefits and costs of dryland forest restoration by means of reforestation with native trees in a study area in central Chile. To determine benefits we applied a Contingent Valuation questionnaire that allowed for the calculation of willingness to pay measures. Restoration costs were calculated based on market prices following existing technical recommendations developed for the study area. Although there was a substantial benefit of restoring forest ecosystem services in the study area, the NPV was negative irrespective of the discount rate used in the analysis, varying between −US$71,000 (−2% rate) and −US$258,000 (8% rate). Only when a subsidy for restoration actions was included, the NPV attained was positive for low and negative discount rates (US$23,600 and US$94,700, for 0 and −2% discount rates, respectively). These results stress the need for developing new compensation mechanisms and enhancing the existing ones, with the aim of encouraging landowners to engage in forest restoration practices. Also, these results bring about the need to carefully consider restoration actions. When there are limited financial resources available to landowners, approaches that promote natural regeneration can be preferable to strategies that imply assisted restoration.

**Reestablecimiento de Quercus rugosa en suelos erosionados en el municipio de Tolimán, Querétaro**

**Narváez Parra, Aslam; Norma Eugenia García Calderón, María del Consuelo Bonfil, Sanders Mayra Gavito**

Instituto de Ecología, UNAM, Mexico

Los suelos erosionados en bosques de encino, cercanos a zonas semiáridas, cubren una considerable extensión en México. Estos presentan degradación por pastizales inducidos, agostadero excesivo y extracción maderable. Bajo estas condiciones, hay regeneración natural de encinos a partir de semillas; sin embargo se desconoce la supervivencia, técnicas de restauración y efecto del suelo. Se probaron dos tratamientos con plantas de dos años de *Quercus rugosa* (aocolchado y en suelo orgánico), dentro de un diseño experimental en bloques; se comparó la
supervivencia de regeneración natural de encinos en dos sitios distintos (cobertura y unidad de relieve); y se caracterizó el suelo en sitios representativos. La ladera presenta suelo de tipo Regosol y el piedemonte, Cambisol; ambos son ácidos, desaturados, con relación C:N < 15 y una CIC media alta (61 a 31.1 cmolc/kg). La supervivencia de regeneración natural fue mayor en sitios arcillosos (valor de P < 0.05). El porcentaje de cobertura vegetal entre vivos y muertos fue 57.4 y 44.8 % respectivamente. El diámetro de la base, altura y cobertura no fue distinta entre tratamientos del experimento y tampoco entre los sitios de regeneración natural (valores de P > 0.05). La supervivencia de Q. rugosa fue similar entre tratamientos, aunque al igual que en regeneración natural, hay aumento de supervivencia en suelos arcillosos. No fue posible discriminar el efecto entre la textura del suelo y la cobertura vegetal en la supervivencia, pero sí identificar su relevancia para la regeneración natural del sitio.

**El uso de material de reciclaje y PVC en viveros de coral de Acropora palmata en el Parque Nacional Sistema Arrecifal Veracruzano**

Nava Martínez, Gabriela Georgina; Miguel Ángel García Salgado, Miguel Ángel Román Vives, Marcos A. Rangel Avalos, Claudia Le Clercq, Israel López Huerta
Oceanus, A.C., México

El programa de restauración que realizan Oceanus, A.C., el Acuario de Veracruz A.C y el PNSAV tiene como objetivo recuperar las poblaciones del coral *Acropora palmata* en sitios de encallamientos del sistema arrecifal veracruzano. En el año 2008 se instalaron los primeros viveros de coral probando exitosamente los métodos de restauración. Para el establecimiento de viveros se utilizaron diferentes materiales de plástico nuevos ( conectores de PVC) y de reciclaje (tapas de PET). Durante las revisiones generales (Fase II) se tomaron datos de altura, diámetro y condición. De acuerdo con los datos del t0 y t1 de los viveros, en los conectores de PVC se registró un crecimiento de 0.33 cm/mes en altura y de 0.47 cm/mes en diámetro. Del T1 al T2, se registró 0.45 cm/mes en altura y 0.6 cm/mes en diámetro. En las tapas de PET se registró una tasa de crecimiento del T0 al T1 de 0.4 cm/mes en altura y 0.6 cm/mes diámetro y de T1 a T2 de 0.85 cm/mes y 0.35/mes. Sobre los conectores de PVC los fragmentos pudieron crecer rápidamente hacia la base fijándose y estabilizándose mejor, mientras que en el PET no pudieron salir de la base para fijarse provocando un mayor crecimiento en altura. Esto fue corregido adecuando los cuellos de botella después de ser fijado el fragmento.

**Ecological restoration projects in practice as a basis for improving local economies: Lessons learnt from forest rehabilitation initiatives in Indonesia**

Nawir, Ani Adiwinita
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Indonesia has to rehabilitate around 96.3 million ha of degraded forest, and at the same time enhance the livelihoods of local people who depend on this forest. Ensuring sustainable restoration with multiplier impacts on local livelihoods beyond the project time is still the biggest challenge. Several successful project cases are characterised by active involvement of the local people using technical interventions that address the specific ecological causes of degradation. It is argued that project-derived economic and livelihood benefits generated from ecological improvements will sustain in the long-term more, than the benefits created directly from project-based economic opportunities.

**The role of beekeeping in restoration of degraded ecosystems and improving livelihood**

Ndelo, Columbus Njuailem; Atemkeng Therese Nkafu
Centre for Development and Community Welfare, Cameroon

Degradation of wetlands and forests (fragile ecosystems) is a serious problem in Cameroon. This is happening despite the existence of legislations providing for buffer zones around these ecosystems. Encroachment and degradation of the ecosystems with their designated buffer zones continues unabated because of increase population of the farming community that sees every inch of land as cultivable land. Under these kinds of circumstances beekeeping can be used to establish win-win interventions in degraded ecosystems and buffer zones that satisfy both socio-economic demands and maintain the ecosystem’s integrity. This presentation will be drawn from an ecological project title promoting sustainable Natural Resources Management in Fontem-Cameroon in which beekeeping is used to restore degraded portions of Fontem. Farmers have been trained in the production of better quality honey and sensitized on beekeeping along water sources in order to conserve the fragile ecosystems. Deliberate campaigns to plant fruit and other useful tree species have been initiated throughout the year providing nectar for bees as well as restoring degraded soils. Farmers have been trained to make beehives and processed and bulk honey. As a result of
increased income from sale of honey and beehives, farmers have been motivated to engage in beekeeping and have established a beehive to protect forest and precious ecological resources from further destruction. Modern beekeeping as illustrated in this area has proven to satisfy socioeconomic demands and at the same time, restores and conserves the ecosystem’s integrity.

Defining novel ecosystems: Biotic, abiotic, and functional dissimilarity

Nelson, Cara R.; Lauren Hallet, Jim Harris, Kris Hulvey, Stephen Murphy, Brian Starzomsky, Pedro Tognetti
University of Montana, USA

Rapidly changing climate and land-use have substantially transformed the structure and function of many ecosystems, creating novel biotic assemblages with no analogues in the historical record. Because of their predominance, there is increasing interest in these “novel ecosystems” and the extent to which they should be considered legitimate targets for restoration and conservation. Here, we explicitly define novel ecosystems with respect to three axes of dissimilarity (biotic, abiotic, and functional) and clarify the role of history in management of these types of systems, based on ideas developed through discussions among thirty-four participants at a 2011 workshop on Novel Ecosystems on Pender Island (British Columbia, Canada). Novelty is a measure of a system's abiotic and biotic dissimilarity from a reference state; novel ecosystems can be either functionally similar or dissimilar from the reference. For instance, an ecosystem that is very dissimilar from a reference in terms of biotic assemblages and abiotic environment yet functionally similar may not be a high priority for management intervention and may even warrant conservation. However, systems that have been drastically altered in all three dimensions - biotic composition, abiotic condition and ecosystem functions - may be undesirable. While all ecosystems can be described in terms of their novelty with respect to biotic, abiotic, and functional dissimilarity, it may be useful to deploy the title “novel ecosystem” for systems that have “crossed irreversible thresholds” with respect to biota and abiotic environment.

What are students of ecological restoration required to learn? A review of academic curricula in the United States and Canada

Nelson, Cara R.
University of Montana, USA

With increasing interest in ecosystem restoration, there is a corresponding need for trained professionals who are prepared to tackle the complex challenges associated with repairing damaged ecosystems. Toward that end, academic programs in ecological restoration are being developed. Because the field of restoration requires knowledge about diverse areas of the natural and social sciences, the best academic programs in restoration should span these disciplines. In order to determine the disciples being emphasized in current academic programs in ecological restoration, I assessed course requirements in 28 undergraduate degree programs identified in a 2009 survey of 300 academic institutions in the United States and Canada with research programs in the ecological, conservation, and natural resource sciences. All 28 degree programs required at least one course in ecology and one in quantitative sciences. In addition, most required at least one course in plant science (89% of programs), human dimensions of restoration (89%) and soil science (74%). Just over half of degree programs required a course in ecological restoration (63%) and in hydrology (56%). However, some disciplines that are critical to restoration success, such as wildlife biology and planning and project management, were included in fewer than half of the degree programs and other key restoration-relevant disciplines were generally uncommon. In particular, atmospheric sciences (22%), horticulture (22%), nonwestern perspectives on resource management (11%), and landscape architecture (11%) were under-represented. These findings suggest a need for additional emphasis on some aspects of restoration, either within formal academic programs or short courses and workshops.

What is the probability that forests treated for fire mitigation will experience subsequent Wildfire?

Rethinking forest restoration in the Western US

Nelson, Cara R.; Tania Schoenagel, Susan Snetsinger, Solomon Dobrowski, Marc-André Parisien, Max Moritz
University of Montana, USA

Forest restoration has become a primary focus of natural resource management in the western US. In fire-adapted forests, much of the restoration emphasis is on fuel reduction. During recent years, federal managers have implemented over 50,000 fuels treatments to reduce risk of catastrophic fire to communities and restore forests and rangelands. Although these treatments are often characterized as ecological restoration, activities primarily focus on reducing the severity of future wildfire, with the goal of deterring adverse ecological impacts of catastrophic fire and
A population restoration attempt for a threatened native deer species (Dama dama) in Turkey

Neyisci, Tuncay
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The only one undoubtedly original wild population of Fallow Deer (Dama dama Linnaeus), a Palaeartic species, is restricted to Düzlercamı Game Reserve (DGR) located around the Termessos National Park in southern Turkey. Current knowledge suggests that this dramatically declined population is genetically distinct from others occurring elsewhere. Mainly because of introductions by the Phoenicians, Romans, and Normans, it is a widespread and abundant species in Europe, hence is listed as Least Concern in IUCN’s Red List of Threatened Species. However, in its Turkish native range this species is under serious threats such as habitat destruction and conversion, inbreeding and poaching. The protection of this tiny surviving population in DGR requires urgent conservation attempts of anti-poaching measures, recovery management, captive breeding, and re-introductions. In 1966, Forestry Department of Turkey initiated the first conservation action by designating the DGR where 6 Fallow Deer were taken into a 34 hectare enclosure for breeding. The conservation program which has mainly focused on breeding for Fallow Deer in DGR has been underway since 1966. In 2003 66 deer were transferred to a 521 hectare enclosure to provide more suitable space and breeding conditions. The present size of the population is composed of 112 captive and some 100 wild. This presentation is going to discuss and summarize the positive or negative effectiveness and the suitability of conservation management decisions taken and practiced during the years 1970-2010. Special emphasis will be given to the ecological effects caused by the exclusion of reoccurring wildfires that occur at a frequency of 9-25 years, on the habitat quality, nutrition and overall health of this genetically distinct captive Fallow Deer population.

Dwelling in the Maya forest garden: Indigenous conservation biology

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At the end of the Pleistocene the lowlands of the Maya culture area contained a much more open landscape than suggested by the exuberant evergreen closed forests that make up the area's 'natural' vegetation today. The climatic change that permitted the expansion of tropical woodlands in the region in the early Holocene coincided with the expansion of human populations, possibly from South America, with a Neotropical ecological culture. The ancestors of the Maya were probably not big game hunters. These human societies, though technologically rustic, were sophisticated shapers of their environment. In a relationship that endured for some 4000 years, humans developed a complex ecological culture, enriched their Neotropical woodland ecosystems, domesticated or adopted dozens of crop species and eventually [settled down in] a brilliant urban civilization, leaving an ecological patrimony that has also lasted many centuries. Europeans arriving in the 16th century found the Maya prospering in their traditional territory and even today, despite tremendous political and socio-economic challenges, some Maya communities continue to dwell sustainably in their forest gardens. Largely under human management for centuries, the Maya forest is strongly anthropogenic in composition, structure and dynamics and represents a great potential factor in favor of biodiversity conservation, though extensive areas are in need of restoration. We examine some aspects of this ecological history and evaluate the suggestion that Maya practices offer ideas for contemporary restoration and conservation of tropical woodlands.

Electricity protects coral from overgrowth by an encrusting sponge in Indonesia

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On some Biorock reef restoration projects in the Maldives and in Bali and Lombok, Indonesia, overgrowth of corals by several sponge species has been a problem. These experiments tested whether sponge growth was accelerated more than the coral growth by electrical currents, shifting competitive advantages to sponges. Direct growth measurements were made of a highly susceptible coral species, *Acropora microophthalma*, and a sponge species overgrowing it, as a function of distance from the electrical field. Results showed that coral growth was stimulated around the Biorock Structure, not only on it, and under it, but also 3 m away from the structure, but not 10, 30 or 100 m away. These results show that in the vicinity of the electrical field stimulated coral growth around the structures to a distance between 3 and 10 m. In contrast, sponge growth was sharply reduced, but only directly on the structure itself. Increased electrical current therefore favors coral survival over sponges on the electrified structures. Increasing the current resulted in a sharp decrease in sponge abundance. The lower growth of sponges on the structure may be due to high pH caused by electrolysis dissolving sponge silica spicules. High abundance of sponge overgrowth on *Acropora microophthalma* on the structures must therefore be due to much higher settlement of sponge larvae on the structure due to attraction by the electrical field and/or unhindered growth on preferred shadowed substrate on the underside of a bar wherefrom sponges attack corals attached on top.

**The benefits of ecological restoration to African women**

*Nkafu, Atemkeng Theresia*
Centre for Development and Community Welfare, Cameroon

As ecosystems, species and ecological communities continue to suffer accelerating decline, damage, and degradation as a result of human activities, the African rural woman is increasingly exposed to the huge challenges in biodiversity and climate change. In essence, restoration is becoming a critical component of nature conservation, ecosystem management, and sustainable local economic development. This has engaged restoration ecologist and practitioners in tackling challenging ecological problems around the globe: - working to repair rivers damaged by dams and diversions and habitat destruction, restore healthy forest ecosystem in tropical and other regions and repair grasslands, salt marshes, coral reef whose ecological interaction has been severely disrupted by overgrazing or human activities. Moreover, in rich and poor communities alike, restoration is increasingly being attempted at all levels, from local community-based projects to national and transnational strategies for sustainability. My presentation will examine if these ecological restoration programmes bring any benefits to disadvantaged rural African women. In seeking to address this topical concern, I have made use of the results and findings from some ecological restoration community-based projects from CEDCOW – CAMEROON and other case studies in Africa. These findings and analysis will demonstrate that ecological restoration can generate enormous ecological, economic, health, cultural, aesthetic, educational and scientific benefits for the African woman and that much attention and emphasis should be placed on ecological restoration.

**Towards evidence-based restoration: The essential components**

*Ntsesho, Phumza; Belinda Reyers, Karen Esler*
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Effective, efficient and sustainable restoration of damaged ecosystems depends on the availability of evidence of effectiveness of alternative interventions. Restoration decisions based on the weighing of such evidence epitomise evidence-based practice. Baseline information collection; setting of clear goals; and monitoring of impact are all essential components of an evidence-based approach to restoration. They comprise the evidence generation aspect of this approach and should be strongly interlinked. An additional component, which is evidence dissemination, requires that effective communication mechanisms are put in place to ensure that evidence is available to guide decision-making. We used South Africa as a case study to examine the strength of the evidence base and to explore the extent to which lack of access to evidence can threaten the advancement of evidence-based restoration. We reviewed literature and surveyed restoration practitioners and managers of ten restoration programs in South Africa. Results showed some weaknesses in all four essential components of evidence-based restoration. Baseline information was sometimes not related to impact assessment; goals were sometimes not documented and quantified; there was limited monitoring of impact; and a considerable amount of the evidence that was not easily accessible in documented form was available as experiential knowledge. We recommend that the planning of restoration programs focuses on setting SMART goals that are based on known baseline conditions and connected to the monitoring of impact. Planning, management and funding processes need to encourage proper documentation of evidence and effective dissemination of such evidence.
Participatory assessment of forest and woodland restoration in the northern Mediterranean

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University of Arizona, USA

Stakeholder participation in the various phases of restoration actions is a critical step for promoting the adoption of good practices. However, suitable protocols to channel stakeholder participation are lacking. We used semi-structured interviews to a group of representative social actors to perform a baseline evaluation of forest restoration actions implemented in two northern Mediterranean sites: Agost (Alicante, Spain) and Pula (Sardinia, Italy). The main outcomes of this process were (1) the establishment of a local knowledge-based set of evaluation criteria and indicators, (2) an evaluation of their relative importance according to stakeholders’ perspectives, and (3) a comparative assessment of restoration actions. In both sites, stakeholders considered themselves to have a deep knowledge of the actions and their outcomes. Stakeholder agreement in assessment criteria was substantial, even among categories of stakeholders originally considered to be in conflict. In both sites, indicators such as provision of goods, flood prevention, biodiversity, recreation use, labor generation, and implementation costs, were recommended for the evaluation of restoration actions. In addition to these, stakeholders suggested a short list of local criteria that may help evaluate site-specific restoration actions. In both study sites, the “No action” option (alpha-grass steppe in Agost, and Mediterranean macchia in Pula) was considered a very good restoration strategy. Old reforestation programs, implemented during the 50’s and 60’s, were also highly valued.

Estudio prospectivo de especies arbóreas con potencial para su establecimiento de suelos contaminados por hidrocarburos

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El Colegio de la Frontera Sur, México

Los derrames de hidrocarburos de petróleo son causa de la contaminación de suelos en Tabasco, los cuales afectan a la flora, fauna, suelo y agua. Poco se ha estudiado con respecto a especies arbóreas con capacidad de desarrollarse en suelos contaminados por petróleo. El objetivo de este trabajo fue el de identificar las especies arbóreas con capacidad de establecerse en suelos contaminados con hidrocarburos. Se inventariaron 12 sitios en los municipios de Huimanguillo, y Cárdenas en Tabasco, México y se entrevistaron a sendos productores. Se registró un total de 646 individuos pertenecientes a 45 especies, entre los que se cuentan árboles, arbustos y algunas especies de palmas. La familia con mayor número de especies es la Fabaceae (7 especies). Entre las especies frutales se registraron el nance, guayaba, naranja, limón, mango y coco. En los cercos vivos el palo mulato, macuilis, hoja de lata, zapote de agua. Las especies apreciadas por su madera son el macuilis, en menor medida el coco, el mango y el macayo chico. En cuanto a las especies resistentes a suelos contaminados encontramos que el escobillo y el tasiste tienen alta capacidad de crecer en chaperos (pasivos ambientales). Se seleccionaron quince especies promisorias para la fitorremediación. Con esta información se sientan bases para orientar a los productores en el uso de especies forestales para el manejo y aprovechamiento de áreas de baja productividad, promoviendo a la vez la restauración con especies nativas.

Evaluación de la tolerancia al arsénico de tres plantas y su potencial uso en fitoremediación de efluentes mineros

Olmos Márquez, Mario Alberto; María Teresa Alarcón Herrera, Ignacio Ramiro Martín Domínguez
CIMAV, México

Evaluación de la tolerancia al arsénico de tres plantas y su potencial en fitoremediación de efluentes mineros La contaminación de agua y suelo con arsénico ha recibido una gran atención en los últimos años, debido a su toxicidad en humanos, flora y fauna. Los drenajes ácidos mineros son una fuente importante de contaminación del agua con arsénico. Los humedales construidos son sistemas que utilizan plantas para remover contaminantes y han sido probados en la remediación de efluentes mineros. En este estudio se evaluó el potencial de bioabsorción de arsénico de 3 plantas (Eleocharis macrostachya, Schoenoplectus americanus y Baccharis salicifolia), se sometieron a diferentes concentraciones de arsénico (1, 2, 3, 4 y 5 mg/L) por un periodo de 10 semanas. Las tres plantas absorbieron el arsénico y lo acumularon en la raíz. E. macrostachya presentó la mayor retención (31%), a concentraciones de 5 mg/L de As. S. americanus y B. salicifolia retuvieron 26 y 13% en su estructura vegetal, a una concentración de 3 mg de As/L. B. salicifolia presentó el factor de traslocación mas alto (4.79) lo cual concuerda con los daños observados en el tejido aéreo de la planta a concentraciones mayores de 2 mg/L. Tanto E. macrostachya...
Restoring biodiverse Mediterranean woodland communities after pine forestry in Western Australia

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A major program in Western Australia aims to restore 9,000 hectares of PinuspinasterAit. (maritime pine) plantations, to protect a subsoil potable water source north of Perth, through reinstating the native Banksia woodland. This study aims to determine if the 50 year persistence of pine plantations has irreversibly altered the soil environment and its ability to sustain the former Banksia woodland ecosystem. Research areas include: topsoil seedbank analyses; physical and chemical soil assessment; seedling establishment, survival, health and physiology trials; combined with an overall ecosystem health analysis utilizing invertebrate and mycorrhizal activity sampling. Soil testing at 500 mm increments to the water table at three sites show elevated acidity, phosphorus (P) and organic carbon levels within P. pinaster soils that may negatively impact native Banksia woodland restoration. Further analysis is underway to isolate allelopathic entities which may influence germination and growth of native species. Mechanically ground P. pinaster pine needles at high concentrations impede native species germination. Areas of cleared pine that remain fallow result in reduced emergence of native species. Invasive weed species management is of particular concern to combat the rapid recruitment and growth of non-native species in areas of cleared pine left fallow. Possible scalping of the soil surface may alleviate any allelopathic and invasive weed concerns which dominate the first 50cm of the soil profile and could be applied for broadscale restoration of Banksia woodland. Seed sourcing, soil alterations and weed management will be the main limiting factors to this broadacre restoration program.

Alternativas de restauración para el hábitat del jaguar en México

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Comisión Nacional de Áreas Naturales Protegidas, México

El jaguar (Panthera onca) es una especie clave en el equilibrio de los ecosistemas, su importancia ecológica y cultural lo convierten en una especie prioritaria para la conservación en México, a su vez está catalogada en peligro de extinción según la normatividad nacional y otros instrumentos internacionales; este felino de amplia distribución, requiere grandes extensiones de hábitat con presas disponibles para mantener sus poblaciones viables a largo plazo, sin embargo, las actividades antropogénicas como la agricultura y ganadería convencional han impactado significativamente su hábitat disminuyéndolo o fragmentándolo. En este sentido y para atender dicha situación, la Comisión Nacional de Áreas Naturales Protegidas a través del Programa de Acción para la Conservación de la Especie (PACE: Jaguar) en su componente de restauración promueve de forma coordinada con los diversos sectores de la sociedad, acciones tendientes a la recuperación del hábitat del jaguar en su área de distribución, entre las propuestas destacan, la identificación de zonas perturbadas “críticas” potencialmente claves para la continuidad del flujo genético de la especie y la implementación de acciones de restauración de suelos, también se fomentan otros esquemas de conservación, como el Programa de Pago por Servicios Ambientales por Conservación de Biodiversidad, las Unidades de Manejo para la Conservación de Vida Silvestre y la creación de Áreas Naturales Protegidas.

Evaluation of restoration – Learning from science and people to improve restoration practice

Orr, Barron
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Conventional environmental assessments tend to be expert-led, top-down activities that generate knowledge for understanding the impacts of management actions. However, unless formally mandated, the results from these approaches suffer poor adoption rates in part because the engagement of local stakeholders is unidirectional and often limited to defining the context at the beginning and delivering the findings upon completion. A participatory and formative approach to environmental assessment emphasizes the co-production of knowledge for action by making all stakeholders, including scientists, part of the assessment team. Local perspectives and priorities drive a process that encourages social learning, setting up the opportunity for collective action. The participatory assessment of restoration actions involves several key elements and methods. First, a comprehensive and representative mix of stakeholders must be identified and engaged, ideally performed through a chain-referral approach to help ensure comprehensive representation. Second, stakeholder-derived assessment indicators, and their relative importance,
must be established. Finally, sharing of perspectives and social learning must be facilitated. Participatory tools for these elements include semi-structured interviews that capture baseline individual perspectives; ranking and weighting methods; Multi-Criteria Decision Aids; empowerment media; collaborative visualization and analysis; interaction and social network tools; etc. These tools ensure that locally defined priorities, processes and preferences are core to the assessment, facilitate the exchange of knowledge among all stakeholders, including scientific knowledge, and enhance the potential that restoration assessment results may actually be used.

**Restoration of severely eroded areas: Progress evaluation in the early stages**

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Restoration of severely degraded land requires methods that modify the physical environment and repair primary processes. To increase understanding of the effects of different reclamation treatments, a large-scale, long-term ecosystem restoration experiment was established in severely degraded land in South Iceland in 1990/2000. The aim is to determine the relationship between soil and vegetation development and repair of ecosystem functions. The experiment consists of untreated controls and nine restoration treatments, representing different intensity and type of input. Each plot is one ha and treatments are replicated four times. Multiple measures are used to evaluate progress, including measurements on both ecosystem properties and functions. Measurements are variable in different treatments due to high cost. Here we present results on soil and vegetation development, nutrient characteristics, hydrological properties and processes, and surface stability. Results show changes in ecosystem processes are concomitant to increased vegetation cover and accumulation of organic carbon in surface soils. Increased infiltration rates, soil water holding capacities, soil microbial biomass, snow cover and surface stability have been observed. The dominant forces driving the successional trajectories appear to be the different restoration methods used and variable natural conditions at the site; including wind erosion rates and soil depth. Land restoration is a long term task aiming at restoring ecosystem function drivers. Current results suggest an improvement of ecosystem functioning, but further research in coming decades will provide answers to whether self-sustainable ecosystems are evolving.

**Site and landscape strategies to restore the tropical montane cloud forests of Central Veracruz**

Ortega Pieck, Aline  
INECOL A.C., México

The Tropical Montane Cloud Forest (TMCF) is the most diverse ecosystem per unit area in Mexico but also the most threatened, accounting for less than 1% of the country’s surface. In central Veracruz, as in other regions, large extensions of TMCF have been cleared, mainly for the establishment of pastures and agricultural fields, resulting in a mosaic landscape where small patches of preserved forest are predominantly present in inaccessible areas and secondary and degraded forest patches are surrounded by agricultural and urban land use. The conservation of these small forest patches plays a key role in the TMCF restoration, as it has been reported that the composition between forest fragments is highly complementary and therefore, their conservation ensures regional biodiversity. Protected areas and forest restoration by degraded forest enrichment, the creation of forest patch connectors and local plantations need both, local and landscape approaches to fulfill restoration goals. In this study, we present data of the landscape characteristics and the restoration activities in two micro-basins in Central Veracruz, Southern Mexico. We analyze the strategies to recover some environmental services and we address the challenges and opportunities to restore this important Mexican ecosystem at country level.

**The importance of peatland restoration for reducing GHG emission in Iceland**

Óskarsson, Hlynur  
Agricultural University of Iceland

Icelandic peatlands have been drained extensively for agricultural purposes. Current estimates indicate that over two thirds of the original peatland area has been altered through the draining and approximately half of the area fully drained. Recent studies have shown these areas to be strong emitters of GHG. However, studies have also shown that peatland restoration can significantly reduce GHG emission or even stop it all together. A majority of the drained peatlands within Iceland are no longer in agricultural use and hence represent a great potential for reducing GHG emission through peatland restoration. For this purpose emphasis is currently being placed on identifying and mapping drained areas, as well as on developing methodologies for verifying restoration success in reducing GHG emission.

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Aspectos ecológicos y de restauración de Acropora palmata (Lamarck, 1816) en el Parque Nacional Natural Tayrona, Caribe Colombiano

Oviedo, María Eugenia; Sven Zea Diego, Luis Gil-Agudelo
Universidad Nacional de Colomib

Las poblaciones del coral Acropora palmata, importante constructor arrecifal del Gran Caribe, han disminuido radicalmente por varias causas. Como el potencial para una recuperación natural es incierto, se requieren medidas de restauración y estudios sobre su ecolología. Para evaluar la influencia de condiciones ambientales y propias de las colonias de origen en el éxito de trasplantes, se obtuvieron fragmentos en tres bahías del Parque Nacional Natural Tayrona, Caribe colombiano, que se sembraron en las épocas climáticas lluviosa y seca. Al final del experimento la supervivencia fue de tan sólo 7 %, pero el área de tejido vivo de los sobrevivientes se incrementó en promedio 46,8 %. El desempeño de los fragmentos durante los tres primeros meses en términos de supervivencia y cambio del área de tejido vivo dependió de la localidad de origen de las colonias donantes y de la época de siembra; la mayoría de los trasplantes perdió tejido y principalmente los de una localidad durante la época de lluvias. Ni el área inicial de tejido vivo ni la porción utilizada de los fragmentos (ápice vs. base de la rama cortada) tuvieron un efecto significativo en el desempeño. La mayor tasa de crecimiento adicional medida en los fragmentos fue de 5 cm/mes. En contraste, las superficies de corte de las colonias donantes sanaron completamente dentro de los primeros tres meses y en cinco meses las ramas ya estaban creciendo de nuevo.

Revegetation of cut-over peatlands in Estonia

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Peatlands cover 22.3% of Estonia and that tiny country holds the 3rd position in the world peat export. The exhausted abandoned peatfields constitute ca 9,500 ha and this area will double in the next decades. To reduce CO₂ and methane emissions, the spontaneous re-vegetation of these areas has great importance in addition to recultivation or restoration. To enhance it we must know well the respective secondary successions and factors controlling these processes on different scales (species, communities, landscapes). In the current study we used the inventory data of 64 cut-over peatlands all over the country carried out by the Geological Survey of Estonia. The main factors affecting the vegetation on species and communities level are the time since the abandonment of the peatland, microtopography, peat pH, ash content, residual peat layer depth, but also the surface peat type and its previous burning are important. Occurrence of fen species and temporary pioneer species is positively correlated with the areas of well decomposed eutrophic peat the pH and ash content of which is relatively high, while areas with oligotrophic slightly decomposed and deeper peat are vegetated with bog species. On the landscape scale the peatland size, its distance from sea and the kind of neighboring areas (forest, grassland, mire) are significant factors. Three successional paths of spontaneous revegetation can be observed: towards (i) meso-eutrophic reedbeds, (ii) meso-oligotrophic birch forests and, (iii) oligotrophic bogs.

Restoration monitoring protocol for the Atlantic Forest Restoration Pact

The Nature Conservancy, Brazil

Atlantic Forest (AF) is one of the world’s most biodiverse biomes. However, only 12% of the original forest area remains. Restoring the ecology integrity of the AF is a major challenge. Atlantic Forest Restoration Pact (the Pact) is a collective initiative of 172 public and private institutions in Brazil with the objective of restore 15 million hectares of AF by 2050. So far, about 40,000 hectares undergoing restoration are registered in the Pact’s database. Several different institutional arrangements and restoration techniques have been used. The purpose of Restoration Monitoring Protocol (RMP), which was developed in a cooperative effort by more than 70 Pact members, seeks to determine which of these methods were most effective and what the results were. The structure of the RMP is based on hierarchy levels: Principle, Criteria, Indicators and Checks. The Principles covered by RMP are predicated on the assumption that successful restoration projects must address Ecological, Economic, Social and Management needs. For each Principle, there are Criteria, Indicators, and Checks associated. Ecological Principle seeks to evaluate whether natural ecological process are being restored, by structure and composition Criteria. Economic Principles seek to provide a better understand of financial mechanisms that support restoration, such as Carbon Markets. Social aspects were included to stimulate the relationship improvement between restoration initiatives, local communities and restoration workers. The Management Principle aim at a good administrative cycle: planning, controls and
Biodiversidad de micorrizas arbusculares en tres tipos de vegetación decidua, Brasil

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Universidade Federal do Ceará, Brazil

En el semiárido de Brasil, la vegetación conservada de los ecosistemas tropicales de bosque deciduo es una de las más amenazadas. En 2009 comenzamos los estudios de evaluación de la simbiosis en las raíces de 32 especies arbóreas exclusivas de la sabana arbórea decidua espinosa (caatinga), del bosque seco no espinoso (con árboles de altura > 7m) y del bosque deciduo de menor altura no espinoso (carrasco) en la Reserva natural de Sierra das Almas. Los 3 tipos de vegetación estudiados presentaron micorrizas arbusculares (MA), siendo muchas de las fanerófitas altamente colonizadas. En el presente estudio encontramos que la mayoría de las especies herbáceas (presentes en el periodo de lluvias) no son micotróficas (solamente dos hemicriptófitas fueron moderadamente colonizadas). Además, MA pertenecientes a cinco familias (Acaulosporaceae, Ambisporaceae, Entrophosporaceae, Gigasporaceae y Glomeraceae) fueron encontradas en la rizosfera de la vegetación arbórea. Estos resultados suministran información relevante para programas de restauración en regiones semiáridas como el estado de Ceará, donde la extracción de leña y la ganadería potencian la degradación de los bosques.

Comparación entre dos estrategias de rehabilitación en áreas degradadas en el valle de San Francisco en los Andes del Sur del Ecuador

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En la actualidad, el paisaje de los Andes of Ecuador está representada por pequeños parches de bosque natural y lo que más predomina son inmensas áreas de pastos que debido a su improductividad con el tiempo son abandonados. Poco se conoce sobre la dinámica de sucesión en áreas de montaña y sobre la ecología de especies forestales nativas y su adaptación en áreas degradadas, lo cuál es necesario para la rehabilitación de estas áreas. Por estas razones, en el valle de San Francisco al sur del Ecuador se instalaron parcelas experimentales en tres sitios sucesionales: Pastos, Llashipa y Arbustivo. En un total de 144 parcelas distribuidas aleatoriamente se plantaron seis especies nativas y se monitoreó el crecimiento anual durante 5 años. En otras 48 parcelas se registro la regeneración natural en términos de riqueza y abundancia de especies leñosas durante cuatro años. Los resultados demostraron, que tanto la sucesión como la adaptación de las especies plantadas dependen de las características ambientales del sitio. El estudio recomienda que los sitios dominados por el pasto Setaria sphacelata deben ser enriquecidos con especies de rápido crecimiento como Alnus acuminata debido a la lenta y pobre regeneración natural de otras especies. En los sitios Llashipa y Arbustivo se sugiere plantar Morella pubescens y Tabebuia chrysantha respectivamente, debido a la capacidad de crecer y sobrevivir mejor y así enriquecer la composición florística de los sitios. En definitiva las dos aproximaciones de restauración tienen que ser complementarias entre sí.

Participación de los actores locales y apropiación en procesos de restauración: Estudios de casos en México y Chile

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A la fecha, se ha implementado un amplio número de acciones enfocadas a la restauración de áreas degradadas en prácticamente todos los ecosistemas. Sin embargo, pocas veces se evalúa la percepción de los actores directamente afectados por dichas acciones. Aquí se presentan 4 casos, 2 en Chile y 2 en México, donde se analizan las respuestas de la amplitud de actores involucrados directa- o indirectamente en la implementación de acciones de restauración, en una primera evaluación de su apreciación de las mismas a partir de entrevistas semi-estructuradas. Los resultados sugieren que el origen de la iniciativa de restauración juega un papel relevante en la percepción que los actores locales tengan de las experiencias. Se discute también la necesidad de incorporar indicadores observacionales a las entrevistas realizadas y de promover la amplia participación de los actores locales en la gestión de las acciones de restauración, a fin de incentivar la apropiación de estas prácticas.
Grandmother’s Prayer

Parker, Lucy
California Indian Basket Maker, USA

California Indians are hunters and gatherers, living off of the land. Basketry is a very big part of the culture. Native California tribes gathered fibers & roots to make baskets to hold water and to carry infants. Basket materials are hand-gathered at different times throughout the year, cured and seasoned. There are two types of basketmaking techniques: coiled & twinning. Dogbane fiber is important for making string which is then used to make nets. Soaproot fibers are used to make brushes for acorn cleaning. Acorn, which is gathered in the fall, is the main source of food for many California Indian tribes. Acorn nutmeats were removed from the shell and then pounded to fine flour. The bitter tannic acid, naturally found in the acorn, is leached away with water. The acorn flour is then placed into a water tight basket and cooked into a soup using hot lava stones to boil the water. This ancient process of acorn preparation has been passed on from generation to generation. Restoration of native plant communities is vital in keeping Native traditions alive. This film will highlight these important traditions and show how new generations continue to follow the paths of their ancestors.

Conservation and restoration of Colombobalanus excelsa in the Andes, Colombia

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Colombobalanus excelsa (Fagaceae) es una especie endémica de los Andes de Colombia, con cuatro poblaciones aisladas cientos de kilómetros en las tres cordilleras y considerada como especie relictual de la familia de los robles. Se encuentra en categoría Vulnerable de amenaza, debido principalmente a la conversión del bosque para usos agropecuarios. Durante quince meses se realizaron evaluaciones sobre la fructificación, lluvia de semillas, banco de semillas y la regeneración natural en las dos poblaciones existentes en la cordillera oriental (Huila y Santander). La dominancia de roble negro es alta en las dos poblaciones estudiadas (IVI de 194.5 y 133.3) y la estructura de clases diamétricas para la especie tiene forma de “J” invertida, sin embargo en las categorías de regeneración natural se encontró que la cantidad de plántulas (< 30 cm de altura), es muy baja. La fructificación fue escasa (15% a 22%) en los periodos máximos. El ingreso de propágulos a través de la lluvia de semillas se presentó solamente en una de las localidades (239.600 semillas/ha/año) y la germinación de las semillas fue muy baja (7,25 ± 0,96 %). No se encontraron semillas de roble negro en las muestras del banco de semillas. Se discute las implicaciones del extremadamente bajo suministro de renuevos y propágulos de roble negro, el riesgo para la persistencia de estos bosques y se determinan las alternativas para su restauración.

Restoration of grass-heath biodiversity within a plantation forest: The invertebrate response to physical disturbance treatments.

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This study examines multi-taxa responses to experimental restoration management techniques that employ differing forms and intensities of physical disturbance. It provides an evidence base for management of grass-heath biodiversity as well as providing evidence for the creation of habitat corridors for open habitat species within plantation forestry. In the absence of natural disturbance regimes, management to restore biodiversity often requires periodic physical disturbance, and in the UK many scarce invertebrates depend on early successional habitats. The Breckland bioregion in the east of England is characterized by low rainfall, sandy soils and a long history of anthropogenic disturbance that created large expanses of grass-heaths. Land-use change, particularly conversion to pine plantations, greatly fragmented and reduced the heaths. Restoration of ecological networks within the open space of the plantation could benefit grass-heath biodiversity by increasing both the habitat available and the connectivity of remnant patches. Established in 2009, this experimental study contrasts six management treatments along a gradient of disturbance intensity. Experimental plots have been established within the trackway network of the plantation and the invertebrate and plant communities have been monitored over the last two years. Results in the first year show that much of the generalist and woodland community dominant in the trackways were greatly reduced in the heavily disturbed plots. By the second year, dense grass-swards are beginning to return to many of the plots and only the most destructive of treatments has potential to support grass-heath communities.
Home gardens as a model system and source of species to convert secondary vegetation into multi-strata agroforestry systems in the Yucatan Peninsula

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In the Mexican tropics, secondary forests are more abundant than mature forests. Unfortunately, few options exist to manage secondary forests in a manner that is profitable for its owners. In this study we identified 38 species that yield food products, grow in at least moderate shade, and can be incorporated into secondary vegetation to produce multi-strata agroforestry systems (MSAFS). These species were identified from a study of 10 home gardens in the Maya zone of Quintana Roo. The species were identified utilizing a methodology that involves asking home garden owners about preferred species and recording ecological information (height, canopy closure where found, and soil type found on) about those species in the owners’ home gardens. Samples of fifteen species were taken to a laboratory to determine nutritional value. If secondary vegetation could be converted to a MSAFS, it would have considerably more value than the relatively low value of crop land and pasture created by modifying secondary forests via slash and burn. Also, converting secondary vegetation to a MSAFS would make it part of a permanent vegetative cover and would contribute to maintaining a higher percentage of forest cover and biodiversity. Constructing MSAFS from secondary vegetation also would strengthen self-sufficient food-production-systems of rural communities in tropical Mexico and in other parts of the tropics. The design of the MSAFS created by introducing the 38 species identified in this study into a secondary forest is the scope of another project.

Studies on the physiological mechanisms of the successful invasion of native plants and its eco-control

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The great damage caused by native invasive species on natural ecosystems is prompting more and more concern all over the world. However, the physiological mechanisms that allow for their success are poorly understood. We hypothesized that native invaders, like exotic invaders, may have higher resource capture ability and utilization efficiency. Ecophysiological traits such as light-saturated photosynthetic rate (Amax), specific leaf area (SLA), photosynthetic nitrogen use-efficiency (PNUE), photosynthetic energy-use efficiency (PEUE), and mass-based and area-based leaf construction cost (CCmass and CCarea) were compared in three pairs of native invasive and non-invasive native species and four pairs of exotic invasive and non-invasive species in Guangzhou, Southern China. The native invaders had higher Amax, SLA, PNUE, PEUE and lower CCmass, CCarea, which were also the traits existing in the exotic invaders. PNUE and PEUE in the native invaders were 150.3% and 129.0% higher than noninvasive native species, while those in exotic invaders were 59.9% and 102.1% higher. Our data showed that native invaders also had higher resource capture ability and resource utilization efficiency. The results indicated that higher resource capture ability and resource utilization efficiency might be a common biological foundation underlying successful invasion. The eco-control of native invaders and the restoration of invaded-land will discussed.

Science, traditional knowledge and common sense in social-environmental systems

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El Colegio de la Frontera Sur, México

Science has become the dominant knowledge system in the world. The preeminence of science produced a superficial reading construing the idea that scientific knowledge is always adequate and enough for the conservation and management of social-environmental systems. Confounded with the above, for many it was implied that local traditional knowledge was unworthy of attention and useless. Some Mexican agriculture ethnobotanists were responsible for the change in perception, moving scientists and technicians to a better understanding and respect of traditional knowledge. The change was so passionate in some quarters that traditional knowledge was equated with scientific knowledge. Notwithstanding, scientific and traditional knowledge are distinct in central aspects of achieving and curating knowledge, such as their objectives, use of terms, methods, measurement, interpretation and the collective structure of their knowledge base and theory. Even though traditional and scientific knowledge cannot be equated, this does not imply that traditional knowledge is always flawed and useless; after all, the survival of many social groups is linked to traditional knowledge. In particular, interventions in complex social-environmental systems disregarding local traditional knowledge commonly have scant likelihood of success and it is not uncommon to find important practical solutions in traditional knowledge upon which science can build. Common sense dictates
that to improve conservation and management success we should go beyond disdaining or misrepresenting traditional knowledge and develop a functional relationship based on an esteem of its strengths, without overlooking its weakness.

Rehabilitación de zonas áridas de la Patagonia Argentina
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A partir del estudio del ecosistema de referencia se evaluó la reintroducción de un conjunto de especies nativas de diferentes grupos funcionales, para la rehabilitación de zonas áridas del norte de la Patagonia. Se realizaron estudios de diversidad y cobertura en sitios desmontados y ambientes de referencia. En sitios desmontados luego de cinco años de abandono la restauración pasiva produjo coberturas menores al 1%. En los sitios próximos hubo escasa similitud acorde al índice de Jaccard y coberturas entre el 18 y 26%. En función de las especies presentes en diferentes condiciones ambientales, la disponibilidad de semillas y los conocimientos básicos de autoecología disponibles, se efectuaron ensayos de supervivencia en campo con uso de hidrogeles de plantines viverizados de Cercidium praeocox, Atriplex lampa, Prosopis flexuosa var. depressa y Schinus johnstonii, y de plantas adultas transplantadas desde zonas aleañas de las especies Stipa speciosa, Senecio filaginoides y Acantholippia seriphoioides. Luego de dos años de plantadas las fabáceas Cercidium praeocox y Prosopis flexuosa var. depressa y el arbusto Schinus johnstonii, tuvieron supervivencia mayor al 50%. En las demás especies hubo alta mortalidad. No se encontraron efectos significativos por efecto de la adición de hidroel. Los resultados muestran la importancia de la consideración de la heterogeneidad del paisaje en la planificación de la rehabilitación y la potencialidad de algunos arbustos nativos para el reinicio de procesos ecológicos en sectores gravemente desertificados de la Patagonia.

La evaluación de la restauración forestal: La descomposición de la hojarasca en tres tipos de coberturas con regeneración contrastante en Costa Rica
Pérez Molina, Junior Pastor; Roberto A. Cordero, S. Silvia Mau Inchaustegui
Universidad Nacional de Costa Rica

La descomposición de hojarasca es clave para el ciclaje de nutrientes, la productividad forestal y puede reflejar la salud del ecosistema. Aquí estudiamos la recuperación del suelo de las zonas del bosque premontano y montano bajo de la región de Orosi, Costa Rica, a través de la descomposición de hojarasca en un cipresal (35 años de edad) y un tacotal (una finca con 15 años de abandono) y los comparamos con un bosque de referencia de aproximadamente 50 años. Medimos la tasa de descomposición (K) de hojas de Viburnum costarricanum en bolsas de micromalla y macromalla (0.3 y 3 mm de abertura, respectivamente), la K de ramitas de Cupressus lusitanica en bolsas de micromalla, la respiración microbiana (R) y la unidad formadora de colonias (IFC) de bacterias y hongos en el suelo. Hubo un efecto significativo del sitio y el tipo de malla en la descomposición de Viburnum costarricanum. La fuerte interacción ocasionada por la macromalla en el cipresal parece un efecto sinérgico por el acceso de invertebrados generalistas. La K de Cupressus lusitanica fue mucho menor que la Viburnum costarricanum y no varió entre los sitios. La R y UFC de bacterias y hongos fue mayor en el bosque de referencia que en el tacotal y el cipresal. Estos resultados evidencian que el tiempo de recuperación y el tipo de cobertura vegetal inciden directamente sobre la comunidad descomponedora, y que afectan decididamente en los procesos del ecosistema. Desde este enfoque, no se recomienda la restauración con ciprés.

La participación comunitaria en la administración municipal y el desarrollo en Santa Catarina
Locíchá, Oaxaca
Pérez Sánchez, Venancio
Universidad de la Sierra Sur, México

Como parte de un proceso de investigación participativa, se construyeron espacios de reflexión-análisis (con diferentes sectores de la población) acerca de las diversas relaciones comunidad-municipio-comunidad y su concreción en eso que pudiera considerarse como desarrollo comunitario, que incluye problemáticas en aspectos ambientales, culturales, económicos, políticos, organizativos. Se estudió el papel que juega la estructura administrativa del municipio con la comunidad y la participación de ésta en los asuntos públicos que enmarcan el desarrollo de la vida comunitaria. Se reflexionó acerca de si realmente la acción comunitaria es, para la estructura municipal y las perspectivas de sus funcionarios, una cuestión sustancial cuya materialización incluya la organización y la participación racional y consciente de las personas, en los diversos niveles de la planeación, problematización y búsqueda de alternativas a los problemas y necesidades comunitarias. Se encontró que el
municipio, como instancia administrativa, pero también de diálogo y construcción comunitaria, se encuentra alejado de las aspiraciones y necesidades particulares de sus habitantes. Así, la participación y la organización comunitaria, son solo elementos de justificación política para la función municipal. La organización derivada de usos y costumbres poco contribuye a la creación de instancias que realmente fueran medios de enlace y de acción para la resolución de los problemas, para la satisfacción de necesidades y mucho menos para la preservación de valores comunes que ayuden a fortalecer tradiciones y cultura de la comunidad. Al contrario, es una forma de organización que se erosiona y se pierde al igual que su entorno ecosocial.

**Participatory selection of forest tree species of common use for rehabilitation of La Lejia microbasin, Cundinamarca, Colombia**

**Pérez Vega, Julieth Stefanie Victoria; Leidy Constanza Acosta Rodríguez, Angela Parrado Roselli**

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One of the most important challenges in restoration ecology is to design strategies that include knowledge, expectancies and point of view of local communities. In this sense, in joint work with the Arbeláez municipality inhabitants, we selected trees species to be implemented in the rehabilitation of la Lejia microbasin. Throughout ethnographic techniques and participatory research tools, we identified the main stakeholders and their responsibilities, priority areas for rehabilitation, the most important tree species by direct and indirect value, and its feasibility to be established in the microbasin. Results showed that the family and the local action committee are the main stakeholders, the former as executives and the latter as supporting agency. Prioritized areas by the community were those affected by cattle ranching due to erosion, flood risk and low productivity. We identified 88 tree species of 40 botanical families of direct and indirect value, of which 30 were selected as the most important ones regarding use and non use values. Of these species 17 can be potentially used in soil conservation and basin rehabilitation. The most important species were balú (*Erythrina edulis*), drago (*Croton spp.*) and the guadua (*Guadua angustifolia*). Empowerment of local community due to this process is discussed.

**Understanding and overcoming the limitations of seedling establishment**

**Pinto, Jeremiah R.; John D. Marshall, Kasten Dumroese, Anthony S. Davis**

USDA Forest Service

Following outplanting, seedling establishment relies heavily on soil moisture and a seedling’s ability to access it. Any factors that limit a seedling’s ability to use soil water negatively affect establishment and can compromise growth trajectories. By selecting the proper type of plant material and understanding the spatial and temporal soil moisture limitations, overcoming the barriers to establishment can be realized. A model of seedling establishment using these two factors has been characterized, through physiological and edaphic data, and is demonstrated for pine regeneration in the Inland Northwest.

**Native plants for native peoples: Empowering Native Americans to grow native plants to meet cultural and ecosystem restoration needs**

**Pinto, Jeremiah R.; R. K. Dumroese**

USDA Forest Service

Native Americans are working to preserve their traditional ecological knowledge, and to develop and enhance production of native plants for spiritual, medicinal, cultural, educational, and land restoration uses. Since 2001, the Reforestation, Nurseries, and Genetic Resources (RNGR) team of the USDA Forest Service has emphasized outreach to Tribes in order to foster long-term collaborations focusing on native plants, nurseries, and educational activities. The RNGR Tribal Nursery Emphasis has three components: 1) ongoing technical assistance to Tribes about collection, propagation, and deployment of native plants, 2) organization of the Intertribal Nursery Council, an annual forum for tribal members to gather and discuss important topics relevant to native plants, and 3) production of a comprehensive guide detailing nursery development and native plant propagation as it relates to specifically to Tribes. To date, the RNGR Tribal Nursery Emphasis has assisted nearly 80 tribes across the US, Canada and Mexico and has worked one-on-one with more than 500 tribal professionals. This assistance has included conducting various nursery training workshops, organizing information sharing meetings, technical assistance, and construction of a greenhouse at an Indian reservation school to enhance conservation education, promote restoration, and provide opportunities for elders to interact with children and share traditional ecological knowledge. Our program will continue to foster technology transfer through the annual Intertribal Nursery Council meeting; seek innovative
partnerships to enable Tribes to develop their own nurseries; and continue to build and maintain collaborative and trusting government-to-government relationships.

Propuesta de restauración ecológica participativa Vereda Mancilla (Facatativá-Colombia)
Pinzón García, Eder Guillermo
Fundación Ie-Sua, Colombia

El proyecto se desarrolla en la vereda mancilla (Facatativá - Colombia) en una zona de bosque seco y húmedo montano bajo. En esta región se han venido presentado alteraciones por la conversión del ecosistema, a través de entresacas y tumbas, en un “archipiélago” de relictos boscosos inmersos en una matriz agropecuaria que amenaza con expandirse y continuar la fragmentación de la comunidad forestal nativa esencial por su generación de bienes y servicios ambientales. El proyecto busca generar conciencia ambiental a través de talleres de sensibilización y capacitación en temas ecológicos, de manera coherente con los procesos antropológicos de nuestra herencia musica cuya cosmovisión se sustentaba en el respeto y equilibrio con la naturaleza. Se fundamenta en un diagnóstico biofísico a partir de la identificación de patrones de uso del suelo, tensionantes, limitantes, barreras para la restauración y el potencial de regeneración (etapa ecológica, fisionomía, composición y estructura del bosque), para definir una línea base del estado actual y el estado deseado posible. El proyecto gestiona actualmente jornadas de extensión comunitaria. Para ello se promueve la conformación de un comité ambiental veredal como escenario para la vinculación activa de la comunidad y establecer así el modelo de restauración en las fincas adyacentes al área de estudio, de manera que se conecten y promover las dinámicas de la biodiversidad endémica a través de un corredor biológico. A la fecha se ha realizado una jornada de recolección de residuos sólidos, revegetalización de humedal y arborización de la escuela vereda Mancilla.

The effects of production systems on earthworm assemblages in vineyards and apple orchards
Pizl, Vaclav
Academy of Sciences of the Czech Republic

Conventional vineyards and orchards belong to agro-ecosystems characterised by extremely high intensity of agricultural practices. The aims of our study were: (a) to find out if the shift from conventional vine and apple production to more nature-friendly systems enhances the diversity and quantitative parameters of earthworm assemblages, and (b) to compare earthworm communities in natural ecosystems with those in vineyards and orchards, and to assess if the implementation of biological production system may lead to the return of rare or endangered species into the agricultural landscape. Three different production systems, i.e. biological (BP), integrated (IP) and conventional (CP), were compared for their effects on earthworms. Commercial vineyards and apple orchards were studied in three production areas in the Czech Republic. In each area, plots under BP, IP and CP, and additionally the closest natural site, were chosen for the study. In spring and autumn 2009 and 2010, soil samples were taken in selected plots and earthworms were extracted by heat using a modified Kempson apparatus. Per-site species number was higher in BP and IP then in CP vineyards and orchards. The community structures in IP sites were similar in all production areas, while those in BP sites differed strongly between production areas. However, the indicators of natural ecosystems (e.g. Allolobophora rabei, Dendrobaena mrazeki, Dendrobaena attemsi) did not colonise adjacent vineyards or orchards. Earthworm density was higher in IP than in BP sites, whereas earthworm biomass did not differ significantly among production systems.

Effective restoration: Understanding the ecology of recovery
Polster, David
Polster Environmental Services Ltd., Canada

Understanding natural recovery processes can help make ecological restoration projects a success. Historically some treatments that have been done in the name of restoration (e.g. agronomic grass and legume seeding) have actually served to slow or even stop the recovery of the disturbed site. In other cases, failure to conduct simple treatments (effective de-compaction of compacted sites) early in the process can lead to the collapse of the restored ecosystem over the long term. Understanding the ecology of recovery can help prevent treatments that work against natural recovery processes. By understanding the processes involved in ecosystem recovery treatments that enhance these processes can be applied. Simple abiotic (physical) treatments can be used to expedite the recovery of drastically disturbed sites. Planting designs that make use of native pioneer species (early successional species) can be used to re-establish successional trajectories that will lead to productive ecosystems that are in accord with the local ecosystems. Later successional species will establish naturally when conditions are appropriate. This paper explores
the ecology of recovery processes and the treatments that can be applied to drastically disturbed sites to assist in these processes.

**Soil bioengineering for slope stabilization and site restoration**  
**Polster, David**  
Polster Environmental Services Ltd., Canada

Soil bioengineering is the use of living plant materials to construct structures that perform some engineering function. Often, soil bioengineering is used to treat sites where surface stability and erosion problems arise. Techniques such as wattle fences and modified brush layers form small retaining walls that can be used to support failing slopes or to reduce slope angles and allow other vegetation to be established. Live pole drains act like “French” drains to provide a preferred flow path for soil moisture and thus drain sites where excess soil moisture is causing instability. Sites where moisture sensitive surface soils are sliding can be treated with live smiles, a wattle fence shaped in a catenary curve that serves to suspend the flowing mud on the slope. Live gully breaks can be used to control seasonal flows in gullies and thus reduce the erosive force of the water while live bank protection can be used to bolster eroding stream banks. Soil bioengineering treatments can be applied to a wide variety of degraded sites. These treatments use natural components of pioneering plant communities and thus integrate well with ecological restoration principles. Soil bioengineering treatments use pioneer species so set the stage for the re-establishment of the natural successional trajectories on the newly stabilized site. Examples of the use of soil bioengineering in restoration projects are provided from the author’s experience.

**Trees from Maya home gardens: Resources for restoration in Yucatán**  
**Pool, Patricia; Juan J. Jiménez Osornio, Patricia Montañéz Escalante, Héctor Estrada Medina**  
Instituto Tecnológico de Conkal, México

A well-known Mayan agroecosystem is the home garden, locally called “solar”. This agroforestry system is the result of a plant assemblage selected by locals through generations, considering positive associations among plants as well as spatial heterogeneity and abiotic conditions. We have identified the tree species that are most important in structuring these production systems. These species are associated since they grow in the same homegardens although not all of them are planted by owners. Some species commonly found in the solars, including *Brosimum alicastrum* Sw., *Sabalyapa C. W rih ex Beccari, Bixa orellana L.*, *Piscidia piscipula* (L.) Sarg, and *Beaucarnea pliabilis* (Baker) Rose, were planted in a quarry to determine their performance under limited and compacted soil conditions. More than 90% of individuals selected in the tree nurseries and transplanted survived. The species presented different growth rates and architecture. According to data recorded during 1.5-years *P. piscipula* is the species that grew tallest (2.10 m), *B. orellana* and *B. alicastrum* had moderate growth (1.5 m) and *S. yapa* and *B. pliabilis* grew less than 1 m. Four different architectonic plant models were identified: Troll for *P. piscipula* and *B. alicastrum*, Scarrone for *B. orellana*, Corner for *S. yapa* and Tomlinson for *B. pliabilis*. These five species have different uses and their potential for restoration at a bigger scale and under different conditions needs to be tested. Mayan homegardens are agroecosystems that can contribute to the restoration process of the region.

**A landscape-scale restoration of dry grasslands using a regional seed mixture**  
**Prach, Karel; Ivana Jongepierová, Klára Řehounková**  
University of Ceske Budejovice, Czech Republic

Large-scale (ca. 500 hectares) restoration of species-rich dry grasslands was conducted using a high-diversity regional seed mixture in the Biosphere Reserve of the White Carpathian Mountains in the Czech Republic, central Europe. Vegetation was analyzed in sites restored 1-11 years ago and compared with that of ancient, extremely species-rich grasslands nearby. Nearly all (98%) sown species successfully established and moreover, nearly half of unsown target species, occurring in the ancient grasslands, established spontaneously. Isolation of the restored from the ancient grasslands exhibited a significant effect on the process of spontaneous establishment of target species. Early mowing in the first half of June appeared to support species diversity and broad-leaved forbs at the expense of competitive grasses. Using the regional seed mixture appeared to be an effective way of restoration of the dry grasslands and is especially recommended in the proximity of still existing ancient grasslands where spontaneous establishment of unsown target species may reinforce the success of restoration.
Cross-cultural Christian workers in ecological restoration and conservation?

Price, David; Robert D. Sluka
LEAD Asia

Religion is a powerful force motivating human behavior. It is increasingly recognized that partnering with religious organizations which may have authority and acceptance in communities can broaden opportunities for conservation practitioners. Christianity has a powerful and eloquent nature stewardship ethic and a strong mandate to alleviate poverty. These attributes, combined with cross-cultural Christian workers’ residence within communities throughout the developing world, makes these workers potential advocates and partners for conservation and restoration activities. We examine the sociological and theological underpinnings for this and address the potential for cross-cultural Christian workers to play an important and strategic role in conservation and ecological restoration. We present four case studies of international Christian organizations and practitioners that have been actively involved in such activities, explore internal and external barriers to success and suggest principles which can facilitate greater synergy. We conclude that cross-cultural Christian workers represent a largely untapped resource and are potentially valuable partners for effecting conservation and restoration globally.

Approaches to community-based mangrove rehabilitation in Panay Island, Central Philippines

Primavera, Jurgenne
Community-based Mangrove Rehabilitation Project, Philippines

Mangrove replanting programs in the Philippines have shown generally low survival rates. Within this context, the Zoological Society of London embarked on a 4-year Community-based Mangrove Rehabilitation Project which covers 8 coastal sites (with partner people’s organizations or POs) in Panay Is., central Philippines. In addition to the decades’ long experience of the author in mangrove conservation, learnings of the CMRP over the past two years include novel biophysical and socio-economic-political approaches. Biophysical protocols pertain to selection of sites (seafront planting vs reversion of abandoned ponds), species (favoured Rhizophora spp vs pioneering Avicennia marina and Sonneratia alba), use of wildings (vs seeds) as initial resource material, direct planting (vs planting of nursery-reared/conditioned seedlings), installation of barriers and breakwaters, and outplanting techniques of seedlings/saplings (size, number, density or spacing). Creative social initiatives that facilitate mangrove rehabilitation are a) NGO (ZSL) networking with local governments and schools, and b) provision of free labor by partner POs as their contribution to mangrove rehabilitation (vs the standard practice of being paid on a per plant or per hectare basis).

How to create and maintain high quality seed stocks for habitat-scale restoration

Probert, Robin
Royal Botanic Gardens, Kew

The starting point for introducing plant species to landscape scale restoration programmes is high viability, genetically representative founder collections of seeds made directly from the wild. Seed collecting methods must reflect the breeding system of the target species and must not threatened the continued existence of the natural population. The optimum time for seed collection often coincides with natural seed dispersal but developmental variation and species differences in the timing of the acquisition of seed quality traits means that considerable care must be taken to ensure that seeds to be collected are storable. Once collected, subsequent seed quality will depend entirely on the humidity and temperature conditions of storage. Careless handling at this stage could result in catastrophic loss in seed viability. Practical methods for ensuring that seed maturity is enhanced and seed quality is maintained during the post-harvest period will be outlined. Once founder collections have been safely stored under low humidity, low temperature conditions, it is essential to monitor viability at regular intervals to ensure that the seeds are fit for use. Founder collections should be stored according to international standards for long-term seed storage in order to maximise seed longevity. Samples, of seeds from these collections are then used for multiplication in order to create, genetically representative, ‘restoration collections’ which will the basis for commercial-scale seed and plant production for restoration schemes. This presentation will focus on the scientific principles that underpin the collection, post-harvest handling and storage of founder seed collections destined for restoration projects.
¿Es la relación luz – Micorriza factor limitante de la germinación en una selva seca Mexicana?

Puc Sánchez, Josué Israel; Luis Alberto Mata-Narváez, María Gabriela Dzib-Ek, Felipe de Jesús González-Ramírez, Rosy Gutiérrez-Jiménez, Horacio Salomón Ballina-Gómez
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Planes de restauración ecológica han sido basados principalmente en selvas húmedas. A pesar que las selvas secas ocupan una extensión mayor, los estudios en ellas son pocos. Aunque la luz no es factor limitante del crecimiento en estas selvas, como si lo es el agua, podría ser que cambios de luz influeran la germinación así como procesos bióticos como las relaciones micorrízicas. Analizamos la relación luz x micorriza en la germinación de especies características de la selva seca. Usamos: *Tecoma stans*, *Senna racemosa* y *Bauhinia forficata*; luz al 70, 50, 30 y 10%; sustratos: tierra de la selva + nutrientes (control), *Glomus intrarradices* (micorriza) y fertilizante químico N-P-K. Estimamos la germinación (%) y su velocidad (IVG). En ningún caso la interacción luz x sustrato fue significativa. En *T. stans* la disminución de luz y el N-P-K incrementaron los porcentajes de germinación. Por su parte, en *S. racemosa* la germinación incrementó pero con el aumento en la luz y la micorriza. Por otro lado, el IVG únicamente aumentó con el sustrato control y sólo en *S. racemosa*. Nuestros resultados demuestran sorpresivamente que aunque la disponibilidad de luz no es el factor limitante del crecimiento de plantas en selvas secas, sí lo es en la germinación. Además, aunque en la literatura se reportan beneficios de las micorrizas, quizá esta relación no necesariamente sea siempre de causa – efecto.

**Mangroves, a global perspective**

Quarto, Alfredo
Mangrove Action Project

Mangroves are the rainforests by the sea. These unique coastal wetlands are essential habitat and nurseries for a wide variety of sea life, including fish, crustaceans and mollusks. It is believed that two thirds of tropical and sub-tropical marine species spend some part of their lives in the mangrove wetlands, which also serve as important habitat for migratory birds and sea turtles. As well, mangroves filter out upland pollutants via their intricate root systems, and protect coral reefs and sea grass beds from sedimentation. Mangroves, once estimated to cover an area of over 32 million hectares, fringe large stretches of the sub-tropical and tropical coastlines of Asia, Africa, Oceania, the Americas and the Caribbean. Today, less than 15 million ha remain... less than half the original area. The importance of the protective mangrove buffer zone cannot be overstated. In regions where these coastal fringe forests have been cleared, tremendous problems of erosion and siltation have arisen, and terrible losses to human life and property have occurred due to destructive hurricanes, storm surges and tsunamis. Today there is a growing urgency to recognize the importance of conserving and restoring protective mangrove greenbelts to lessen the dangers from future catastrophes, because as sea levels rise so will the frequency and intensity of hurricanes and storm surges. Mangrove Action Project (MAP) is working with other organizations in the global South towards restoring degraded and cleared mangrove areas as a high priority.

**Pollination networks in tropical dry forests**

Quesada, Mauricio; Yunuen García Rajas, Martha Lopezaraiza-Mikel
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Habitat modification results in a matrix of secondary succession where pollinators are of crucial importance for the reproduction and subsequent regeneration of most plant species. There is a shortage of information on how plant-pollinator interactions change along secondary succession. The objective of this study is to analyze changes in diversity and structure of plant and pollinator communities, and pollination networks along a successional gradient of tropical dry forest. We sampled plant-pollinator interactions in early, intermediate and late successional sites of tropical dry forest in the Biosphere Reserve of Chamela-Cuixmala, Mexico, and surrounding areas. We found more plant species flowering, more plant species visited by pollinators, and a higher floral abundance at early successional sites. As a consequence, a higher number of pollinators are attracted to these sites, which results in higher pollinator species richness. Network asymmetry is higher at early successional sites, where pollinators tend to be more generalist and there are a higher number of interactions. Network specialization tends to be higher at late successional sites, nevertheless, interaction evenness remains constant along the successional gradient. Our results show that secondary forests have a diverse pollinator community, but changes in species composition results in a more generalist pollinator community.
Strategies for restoration of the Waikato River, New Zealand, through co-management between indigenous Maori and the government

Quinn, John; Kit Rutherford, Bryce Cooper, Bruce Williamson, Erica Williams, Gail Tipa
National Institute for Water and Atmospheric Research, New Zealand

A 2010 Act of Parliament aims to settle a treaty claim by indigenous Maori to reverse the degradation of the Waikato River that occurred following confiscation of land and assumption of authority by colonial settlers in the 1860s. It established a co-management authority (50:50 Government-Maori) to promote an integrated, holistic approach to initiatives to restore and protect the health and well-being of the Waikato River for future generations. This paper describes a study to support this new Authority that combines traditional knowledge with contemporary social science, biophysical science, and economics. It examines the pressures on the river, its current and desired states, and potential restoration strategies, focusing, in particular, on indigenous Maori values. Sixty recommended priority actions were developed and assessments made of their capital and operating costs, benefits and co-benefits, and overall economic effects on the region and nation (input-output modeling), over a 30-year duration. Some benefits could not be ascribed a monetary value (e.g., recreation, well-being). Catchment modeling and expert judgment were applied to predict the magnitude and timescales of indicator responses to restoration scenarios. These actions cover governance, engagement, management of diffuse and point source contaminant sources, access, fisheries, lake restoration and protection. A novel report-card system, grounded in indigenous values, was developed to monitor progress of action and state indicators to support adaptive management.

Trigger point theory as aesthetic activism

Rahmani, Aviva
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Trigger Point Theory hypothesizes how aesthetics can integrate with science to solve global degradation caused by habitat fragmentation, extractive industries and global warming, particularly in coastal zones. A methodology of twelve premises and eight principles developed from the ecological restoration art project, Ghost Nets 1990-2000, which restored a small coastal patch in the Gulf of Maine. Ghost Nets was a series of heuristic experiments and as another way to redefine public art. Research methodologies included Geographic Information Systems (GIS) and performance, to produce Ghost Nets, the referential site for Trigger Point Theory. Current research addresses the relationship between the performative aesthetic methodology that produced Trigger Point Theory from Ghost Nets and how this approach may increase endemic resilience at large landscape sites of anthropogenic degradation. The Ghost Nets ecological art project, continues to be a test case to explore and question the limits of how the role of expert witness systems might be expanded. Those questions and how the hypothesis might be applied to other sites are being tested in webcast events with teams of scientists ("Gulf to Gulf") and live Trigger Point workshops, which address a range of related concerns, from the BP spill to the impact of fracking. Research that contextualizes this approach includes environmental modeling questions that cross landscape ecology, GIS and biogeography, underpinning how art may function as an expert witness for the careful selection of nuclear sites. The conclusion of this research is that this transdisciplinary approach to environmental restoration may parallel and support agent-based methodologies.

Restoration in cities: Adjusting ecological thinking to the reality of complex and rapidly changing landscapes

Ramarho, Cristina; Richard Hobbs
University of Western Australia

Cities are expanding worldwide at an unprecedented pace, with UN figures predicting the world urban population to double and medium size cities to triple their area between 2000 and 2030. As cities grow larger and larger, enhancement and restoration of the fragments of native vegetation that are left in the urbanizing matrix is increasingly important for conservation and human well-being. Restoring ecosystems demands an a priori understanding of the observed patterns and of the processes and dynamics that are responsible for those patterns and that potentially govern the system in its trajectory of recovery. In the urban context, understanding these patterns, processes, and dynamics requires ecologists to consider one important aspect often neglected in traditional ecology - time. Indeed, cities are complex, multi-scalar, young, and highly dynamic landscapes, and consequently its remnant communities are far from equilibrium, but in a process of adaptation to the novel surrounding environment. For this reason, we believe it is fundamental to consider temporal dynamics of landscape change as these hold information
that is crucial to understand the current biotic and abiotic conditions of urban remnants. We suggest that restoration efforts in cities should be supported by the adoption of a temporal perspective that takes into account previous landscape configurations and land use legacies and views remnant communities as being in a range of relaxation conditions due to different fragmentation trajectories. This approach will allow the identification of realistic restoration goals and the prioritization of remnants to be set aside and targeted with restoration efforts.

Restauración de la selva baja estacional en dunas costeras empleando un sistema artificial de retención de semillas anemócoras y zoócoras

Ramírez Pinero, Mayitzza; Sergio Antonio Guevara Sada
INECOL Xalapa, México

La selva baja en México es uno de los ecosistemas más importantes por su extensión y biodiversidad, 73% ha sido alterada por la agricultura y la conversión a pastizales (Trejo y Dirzo 2000). La regeneración natural está limitada por la inmigración de semillas debido a la estructura de la vegetación y la ausencia de recursos para los frugívoros dispersores (Corlett y Hau, 2000). Esta investigación desarrolló una técnica de restauración basada en aumentar la llegada de semillas anemócoras y zoócoras. El experimento se llevó a cabo en un pastizal de dunas costeras del centro de Veracruz, México. Las semillas dispersadas por frugívoros se capturaron bajo 10 árboles aislados de Diplphysa robinioideus y 10 perchas artificiales (2 tratamientos). Las semillas dispersadas por viento se capturaron alrededor de individuos aislados de Opuntia stricta y de trampas artificiales (2 tratamientos). Los tratamientos se agruparon en 10 unidades. Las semillas se capturaron cada 15 días en 100 trampas de tela (2 trampas en cada elemento). Se censaron las aves que visitaron los árboles y perchas. La abundancia de semillas en cada tratamiento y la abundancia de aves muestran que la llegada de semillas dispersadas por viento supera la cantidad de semillas dispersadas por aves. En la temporada de migración de las aves las perchas artificiales muestran mayor riqueza de semillas. La combinación de estos dos dispositivos es efectiva para aumentar la inmigración de semillas al sitio.

Strategies for restoration programs in the Caribbean region

Ramos Peña, Maribel; Francisco Herrera, Maribel Ramos, Saúl Flores, Laura Hernández, Bárbara Muñoz, Marisela Bravo
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Land degradation in the tropics seriously affects fresh-water availability and biological diversity. Restoration plans have been developed, however they rarely involve local species, and ecological aspects are usually not considered in reforestation programs. This problem is common to northern Venezuela’s region, and many Caribbean countries. However, Cuban and Venezuelan researchers have been investigating on promissory species for ecosystem recovery after fire and soil erosion, for the last four years. We have been studying in detail 21 tree species, after a screening of 358 spp. occurring in an altitudinal gradient from sea level up to 2,300 m a.s.l. The selected species are dominant in secondary dry and mountain tropical forests, and have a Neotropical distribution. Nevertheless, little is known about germination strategies, seedling emergence, impact on soil formation processes and usefulness in restoration programs of most of them. For instance, seed germination has been improved in more than 60% when applying pre-germination treatments to, Prosopis juliflora (98%), Chochlospermum vitifolium (84%), Heliocarpus americanus (60%), Guazuma ulmifolia (96%), Ochroma pyramidale (80%), etc. Seed viability has been tested using the tetrazolium test resulting in: seeds viable after six months, Bauhinia aculeata (99%), and Heliocarpus americanus (62%), Guazuma ulmifolia (93%), Prosopis juliflora (99%) after one year. These data, together with litter quality determined by ICP-MS, the effects of water regimes on seedling survival and growth and local knowledge, provided a useful guide to improve the success of restoration programs in the Caribbean region when considering these promissory species.

Modification of 12-row commercial crop planters for cheap landscape-scale restoration of farmland with native vegetation

Reid, Nick; David Carr, Leah MacKinnon
University of New England, USA

Restoration of extensive farmland with native vegetation to rehabilitate degraded land, return cropland to native grassland and woodland for commercial grazing, establish windbreaks and wildlife corridors around large cropping paddocks, or for biodiversity and carbon benefits, is prohibitively expensive. Current methods in Australia rely on small-scale manual planting of tube stock or direct seeding using single-tyed planters designed especially for native tree and shrub sowing. In order to develop a cheap revegetation technology for broad-acre application, we worked with farmers in north-west New South Wales by helping them modify their commercial 12-row precision planters
used for the direct drilling of crops, to sow native grass, shrub and tree seed. In an initial trial at four 2-ha sites during drought, nine grass and shrub species had established 1 year after sowing. Major advances to this point include (1) enthusiastic farmer engagement, (2) successful farmer modifications of commercial agricultural seeders to sow native plant seed, and (3) partnerships between the Border Rivers - Gwydir Catchment Management Authority, Greening Australia, amateur and professional seed collectors and a commercial seed technology company to collect and prepare native seed for sowing. The use of conventional chemical fallowing techniques holds promise in combating competition from crop weeds. Our results underscore the need to customize the technology for local conditions, research the many unknowns about the seed ecology and germination requirements of the local flora, and for participants to continue to learn together about the many factors determining revegetation success.

**Estrategias de restauración en los programas de acción para la conservación de especies en riesgo**

Rendón Hernández, Eduardo; Patricia Oropeza Hernández, Rogelio Erick Manríquez Martínez

Comisión Nacional de Áreas Naturales Protegidas, México

La pérdida de hábitats y la fragmentación de ecosistemas, se han convertido en las principales amenazas para el mantenimiento de la biodiversidad y los servicios ambientales, en este sentido, programar acciones tendientes a detener la pérdida de hábitat y a restaurar áreas que incrementen la cobertura vegetal o que funcionen como corredores biológicos debe ser una de las principales estrategias en la gestión ambiental actual. Por tal motivo, en el Marco del Programa de Conservación de Especies en Riesgo de la Comisión Nacional de Áreas Naturales Protegidas (CONANP), se están implementando los Programas de Acción para la Conservación de Especies (PACE). El PACE es un instrumento de gestión para cada una de las 30 especies prioritarias de México consideradas por la CONANP, en él se plantean las estrategias y acciones que se deben llevar a cabo para lograr la conservación de las especies y su hábitat con el apoyo de los diversos sectores de la sociedad. El PACE cuenta con un componente de Restauración que a su vez tiene dos vertientes, la restauración de ecosistemas y la prevención y mitigación de impactos, la primera tendiente a recuperar zonas degradadas o fragmentadas en áreas de distribución actual y potencial de las especies prioritarias y la segunda como una medida preventiva encaminada a la conservación del hábitat.

**Potencial de poblaciones sucesionales de Byrsonima crassifolia para restauración de suelos degradados mediante reactivación del ciclo biogeoquímico**

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Universidad Nacional de Colombia

La desertificación de tierras ocupa primera importancia en la agenda ambiental mundial conforme compromete la seguridad alimentaria y la prestación de servicios ambientales. Se presentan resultados de un estudio del ciclo biogeoquímico (CB) en poblaciones sucesionales de Noro (*Byrsonima crassifolia*) de seis años de edad, localizadas en tierras secas degradadas por sobrepastoreo en Antioquia, Colombia. La hojarasca fina anual representó 901 kg ha⁻¹, con una participación del 53% de hojas de Noro y del 25% de material reproductivo. El mayor retorno potencial anual de nutrientes vía hojarasca foliar fue de Ca (42 kg ha⁻¹) y el menor de P (1 kg ha⁻¹). A partir de la constante de descomposición anual de la hojarasca foliar (k=3.4) los retornos anuales de materia orgánica y C al suelo representan 462 y 111 kg ha⁻¹ respectivamente. Al comparar los parámetros edáficos entre sitios bajo Noro y sitios testigo, se determinaron incrementos absolutos de 2.19 veces en la CIC y 2.04 en el contenido de materia orgánica. De aquí que las poblaciones de Noro a pesar de su corta edad, permiten a través de aportes de materia orgánica y nutrientes vía hojarasca fina, reactivar el ciclo biogeoquímico y revertir el proceso degradativo edáfico, constituyendo una atractiva estrategia de restauración pasiva el favorecer el avance de su proceso sucesional.

**Mujer: Participación comunitaria y horizontes para el desarrollo sustentable**

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A través de la historia han existido en el mundo desigualdades entre hombres y mujeres. Las características biológicas como el sexo y las formas de auto-organización, se han utilizado como base para atribuirles ciertos comportamientos, actitudes, roles, capacidades y posiciones en la sociedad. Se han construido géneros, masculino y femenino, que han implicado formas diferenciadas de vivir para los hombres y mujeres. Las desigualdades en la mujer no sólo se han manifestado en la familia, sino también en la comunidad disfrazadas de usos y costumbres como forma de autoorganización. En el Estado de Oaxaca los usos y costumbres han representado un factor importante para la violación de los derechos humanos de la mujer, principalmente en el proceso de participación para
Integración del conocimiento local y técnico en la selección de especies útiles para la restauración de la Reserva de la Biosfera Volcán Tacana, Chiapas, México
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Se propone una estrategia de recuperación de los paisajes naturales y sistemas productivos de la Reserva mediante la elaboración de dos componentes: 1) muestreos sobre los ecosistemas de la Reserva y 2) selección de especies mediante talleres participativos con las comunidades. Se realiza una clasificación no supervisada (Spot image, 2007) del uso de suelo y vegetación a escala 1:20,000: Selva Alta o Mediana Subperennifolia, Selva Mediana o Baja Perennifolia, Encinares, Pinares-Encinares, Pinares, Paramo de Altura, Zona de Agropecuaria. Por ecosistema y tipo de manejo se muestrearon tres parcelas circulares de 1000 m², obteniendo datos de estructura y diversidad de cada uno de ellos, a excepción de los dos últimos ecosistemas mencionados. Para proponer las especies multipropósito útiles en la restauración se realizó el siguiente proceso: a) consulta en gabinete los usos de las especies registradas b) socialización de la información a las comunidades mediante talleres diagnósticos c) cruce de la información documentada con la información obtenida a través de los talleres mediante el software multi criterium IRIS 2.0. Se identificaron 12 especies arbóreas como potenciales y siete usos. La participación de las comunidades en el proceso de restauración ha sido crucial para la viabilidad del establecimiento y manejo de las especies; su conocimiento y contribución en el desarrollo de la parte práctica del proyecto ha permitido fortalecer la organización en las comunidades.

Restoration and adaptation to climate change in natural protected areas: A landscape approach
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Given the importance of the impacts of climate change on Mexico’s ecosystems, Mexico’s National Commission for Protected Areas (CONANP) developed the Climate Change Strategy for Protected Areas. To support the implementation of this Strategy, CONANP, in coordination with the Mexican Fund for The Conservation of Nature and The Nature Conservancy, designed the Pilot Program for Adaptation to Climate Change in Natural Protected Areas in Southeast Mexico. This project was developed in four Protected Area Clusters with a landscape approach, involving regional ecological processes and similar socioeconomic context. This presentation provides an overview of the results for the project held for the region Selva Zoque, one of the most diverse regions in Mexico. The climate change trends used for this project based on the official scenarios for Mexico show a raise in temperature and a decrease in annual average rainfall. A vulnerability analysis was made, identifying the potential impacts of climate change on conservation targets, such as ecosystems and communities. Climate change impacts for this region include more frequent and intense forest fires, ecosystem reduction and savannization. Thirteen adaptation strategies were identified, among which are the promotion of resilient and competitive productive activities, the implementation of a regional alert system for forest fires and the enhancement of ecosystem connectivity through active ecosystem restoration, considering native species and control of invasive species. This actions and measures will be oriented to increase ecosystem and human resilience and will be carried out in coordination academic institutions, civil society and local governments.

Restauración ecológica de 1,101 hectáreas en el Área Natural Protegida Cuenca Hidrográfica del Río Necaxa para compensación ambiental por construcción de 38.5 kilómetros de la autopista México-Tuxpan
Riaño Ramírez, Noel
Ojo de Agua, México
Las actividades de restauración ecológica de 1,101 hectáreas en el Área Natural Protegida “Cuenca Hidrográfica del Río Necaxa” se realizan como medida de compensación por construcción de la autopista México - Tuxpan del km. 140+243 al km 178+500. Las actividades son financiadas por la empresa Concesionaria Autovía Necaxa-Tihuatlán S.A de C.V. y ejecutadas por la empresa Ojo de Agua. En el año 2009 se plantaron aproximadamente 1,200,000 árboles de *Pinus patula* (49%), *P. greggi* (47%), *P. pseudostrobus* (3%) y *P. montezumae* (1%) en 217 predios de 143 propietarios en 41 comunidades de 7 municipios. También se realizaron obras de conservación de suelos en 500 hectáreas. Para su protección se cercaron 200 hectáreas y durante 4 años (2010-2014) se realizarán desherbes, fertilización, educación ambiental, control de plagas y enfermedades, prevención y combate de incendios forestales y reposición del 19% al primer año de plantación. En el año 2010 la Universidad Autónoma Chapingo realizó una evaluación de la sobrevivencia. Se eligieron al azar 237 sitios cuadrados de 100 m2 en 40 predios, los cuales cubren una intensidad de muestreo de 0.215%. El valor inferior del intervalo de confianza fue igual a 1,266.9/ha, con una confiabilidad del 95%. 60.5% de los árboles muestreados fueron *P. patula*, 37.4% *P. greggi*, 2.0% *P. montezumae* y menos de 0.1% *P. pseudostrobus*. La supervivencia general fue del 97.35%; de los cuales *P. patula* tiene 97.43%, *P. greggi* 97.07%, *P. montezumae* 100% y *P. pseudostrobus* 100%. El 4.4% de los árboles vivos registrados en el muestreo, son reposiciones.

**Ant diversity in restored areas of Brazilian Atlantic forest**

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Although several studies have aimed to restore the Atlantic rainforest, data on restoration of wildlife are virtually nonexistent. Among all the species that occur in tropical forests, we could highlight the ants as the most abundant animals, with higher biomass, and with a remarkable diversity of species. Ants play a main role in forest dynamic, affecting seed dispersal, seedling establishment and the abundance of insect herbivores. Here, we tested if the distributions of ant species in restored areas of different ages differ from that in a native forest. In addition, we indicate how some habitat features can affect the species distribution patterns. Our results suggest that the composition of restored areas with different ages could be changing according to age. Noticeable species turnovers occur among areas and some ants could be replaced by others during the restoration process. Our results showed that the genera *Atta* and *Acromyrmex*, usually associated with disturbed habitats, were detected more often in young areas than in old ones. On the other hand, the army ants of the genus *Labidus* were found only in the native forest. *Gnamptogenys* and *Hypoponera* were more associated with areas that had structured layers of leaf litter with more available N and humidity. Such ground conditions were achieved only in old restored areas (more than 10 years after implementation) and could act as a filter preventing *Gnamptogenys* and *Hypoponera* ants to colonize young restored areas.

**Seed collecting of native species as a mean of social integration of traditional communities in rainforest restoration**

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The need to expand and improve seed collecting, conservation, and plant propagation techniques in the context of rainforest restoration is an opportunity to create jobs and livelihoods, and to foster and revive traditional activities related to forest trees and the forests themselves, within a new socio-cultural context, and with new functions and pay-offs for the local participants. Different strategies of seed acquisition, and use involving different groups of seeds, are desirable to increase the inclusion of traditional indigenous communities or individuals in the restoration process. Indeed, traditional populations generally live nearby or even inside the forest and are intimately familiar with the distribution and phenology of many native plant species. Additionally, seed processing and use of native tree and shrub species normally demand a large amount of workers, since most procedures are non-mechanized and depend on careful handling of many fruit types. Unfortunately, as elsewhere in the world, such peoples are continuously moving to the cities in search of jobs and higher income. Considering that most seed harvesters are non-qualified workers (at least for regular jobs), and that most of them earn a minimum wage, when they get a job in the city, seed collecting and nursery plant production offers a highly favorable alternative either as a full-time job, or as a way to obtain seasonal, or complementary income for rural workers, or even to small-scale farmers and landowners. In this context, the ecological restoration process can offer valuable job and income-generating opportunities for traditional and local populations, which have to be better explored in restoration projects in the future.
Los pescadores de Puerto Morelos, con apoyo de Comunidad y Biodiversidad, decidieron ceder parte de sus derechos de pesca para el establecimiento de un refugio pesquero en el PN Arrecife de Puerto Morelos. Su objetivo para esta zona de protección fue dejar espacios donde las especies comerciales y no comerciales y el arrecife en general pudieran recuperarse, y funcionar como un sitio de amortiguamiento para todas las amenazas que actualmente enfrenta el sistema arrecifal. A cuatro años la cooperativa de pescadores tiene un equipo técnico en monitoreo que ha llevado las valoraciones de la salud arrecifal y la vigilancia de su refugio. A pesar de que el refugio ya está dando buenos resultados, la presencia del pez león preocupa a los pescadores, ya que pone en riesgo a la actividad pesquera y el éxito de la restauración ecológica. Esto ha provocado que la cooperativa pesquera actúe para el control de esta especie invasora a través de torneos de pesca de pez león, y el impulso de un nuevo mercado de consumo humano con eventos de degustación para la comunidad. Con estas acciones los pescadores pretenden seguir siendo protagonistas en la conservación de sus recursos y ecosistemas, con el cuidado del refugio pesquero y control del pez león, para el bienestar del arrecife, el cual es la base económica de la población.

**Horticultural techniques for rapid establishment of herbaceous layers in young urban woodlands**

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In an urban context, sustainable forest management should be able to provide both high recreational values as well as opportunities for biodiversity conservation. One important but often overlooked aspect is the establishment of woodland herbaceous species. New woodlands established on former agricultural or industrial land often have limited capacities to develop diverse herbaceous layers within reasonable time because of limited colonization capacities of many woodland herb species. In gardening and park management the use of horticultural techniques for soil improvement has been well investigated, but the application of similar methods in woodlands has been much less explored. We performed a fully randomized two-factorial block design experiment in a 13-year old *Quercus petraea* stand established on former agriculture land in Southern Sweden to investigate the effect of compost and weeding on the establishment and growth of three summer-green herb species (*Galium odoratum, Lamiastrunum galeobdolon, Stellaria holostea*). The results show that growth and flowering increased dramatically (4- to 10-fold) depending on the species when planted in compost compared to control plots. Removal of competing vegetation had no significant effect. Although large-scale application of this method may prove to be an expensive strategy, the results are promising for instant establishment of attractive herbaceous layers at strategic locations. The method may also be applied in woodland restoration projects to create local dispersal pools in order to accelerate the future colonization of the forest floor.

**Especies vegetales para el enriquecimiento del bosque en la comunidad indígena de Macedonía, Amazonia Colombiana**

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El resguardo indígena de Macedonía ubicado en el Amazonas Colombiano, es una comunidad para la que la artesanía es la principal fuente de ingresos económicos. Sin embargo, actualmente se reportan escases de algunas especies vegetales. Por lo tanto, con el fin de contribuir al enriquecimiento del bosque y suplir las necesidades de materia prima esta investigación identificó las principales especies para enriquecer el bosque sobre las que se realizaron ensayos de propagación. Por medio de métodos etnográficos, y herramientas de investigación participante se seleccionaron las especies forestales útiles y se reunio información local sobre sus usos, estado sucesional, forma de propagación más apropiada y disponibilidad de material vegetal. Las especies seleccionadas y con material disponible se propagaron en vivero comparando la supervivencia y el desempeño (altura y número de hojas) para estacas, semillas y plántulas rescatadas bajo la sombra del parental. Los resultados muestran que las especies más importantes fueron aquellas que representan un valor de uso directo por parte de la comunidad, bien sea como subsistencia o comercial. Dentro de las especies más importantes para subsistencia están *Inriartea deltoidea*, Capironasp. e Inga sp. y para uso comercial *Brosimum rubescens, Astrocaryum chambira y Cedrela odorata*. El rescate de plántulas fue el método de propagación más efectivo para todas las especies en términos de supervivencia.
A genetic assessment of ecological restoration success in Banksia attenuata

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Despite the widely acknowledged importance of genetic management for the long-term resilience, functionality and self-sustainability of restored natural systems, genetic assessments of restored populations, and, critically their offspring remain rare. A founding population sourced from a limited genetic pool of non-local provenance seed can result in genetic bottlenecking and inbreeding, potentially reducing future population resilience and restoration success. We used microsatellite markers to assess the genetic variation of natural and restored populations, and their offspring in Banksia attenuata R.Br. (Proteaceae), a keystone species of Banksia woodlands in south-west Western Australia. Both natural and restored populations, and their offspring, displayed similarly high levels of heterozygosity (He range = 0.57-0.62) and allelic diversity (Ne range = 6.67-8.86) across seven microsatellite loci. There was very weak population divergence (FST = 0.006) between the restored population and the adjacent natural population, indicating local provenance sourcing of seed. Genetic structuring within the natural population was weak but detectable at small distances and more strongly genetically structured than the restored population (Sp = 0.006 and 0.002, respectively). Complete outcrossing, low correlated paternity and very low bi-parental inbreeding was observed in both populations. Extensive pollen dispersal was observed within and among populations, with > 50% of paternity assigned to sires beyond the local population. Results indicate the successful genetic management of B. attenuata in this restoration project, from which general principles emphasizing the use of diverse local provenance seeds, genetic integration and delivery of pollinator services are supported.

Cultivo de samambaia-preta para recuperación de áreas impactadas por la explotación de carbón: Alterativa socio económica y ambiental para uso futuro

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En el estado de Santa Catarina, sur de Brasil, la explotación de carbón mineral a cielo abierto dio origen a áreas degradadas que precisan ser recuperadas en sus características físicas, químicas y biológicas, y cuya comunidad necesita de un nuevo sistema de producción de renta, con inclusión social. La samambaia-preta (Rumohra adiantiformis (G.Forst.) Ching) es una planta nativa del Brasil y comercializada mundialmente para uso en floriculturas en la confección de arreglos florales, y puede llegar a ser una alternativa para aumento de la renta de comunidades mineras. En la fase inicial de recuperación ambiental se forma un ambiente característico para el desarrollo de la samambaia-preta, debido al plantío de especies pioneras como la bracatinga (Mimosa scabrella Benth.) para recuperar estas áreas. Dentro de este contexto, el objetivo de este estudio fue evaluar el cultivo de samambaia-preta como alternativa para recuperación de áreas degradadas por la explotación de carbón a cielo abierto, visando a oportunidades socio económicas y ambientales. Fueron analizados datos obtenidos a partir del plantío experimental de la samambaia-preta en área de recuperación ambiental y, fue constatada la viabilidad de su cultivo. La población cultivada en estas condiciones presentó el dinamismo característico de la especie, indicando su potencial de uso y posibilidad de inclusión social de comunidades locales, proporcionando fuente de renta adicional a través de un producto forestal no maderero.

Environmental and social impacts of the economic change in the Mexican Gulf region (1980-2010)

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As a unique and fragile ecosystem, the Gulf of Mexico is suffering a devastating set of environmental impacts and hazard. The never-ending needs of world energy supplies cause the increasing of exploring and extractive activities in order to respond to International trade expansion, and the fulfillment of touristic and urbanization demands. These processes also imply building port facilities with larger capacity and new infrastructure to transport the products of a growing economy, causing similar damages: a new wave of deterioration of the scarce ecosystems that the region conserves. Also, wealth polarization broadens the gap in human development indexes. This paper analyses several economic and social statistics to show the relationship between environment and globalization in this region.

y desempeño, mientras que las estacas no mostraron resultados positivos. Se discute la importancia de la creación de viveros comunitarios y del trabajo con la comunidad para el éxito de este tipo de estrategias.
Setting priorities for restoration in protected areas

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Restoring degraded ecosystems is the urgent call in conservation science, after evidence of the biodiversity crisis, especially in the tropics. An effective conservation has been achieved with the creation of protected areas. However, the number of protected areas is not a reliable indicator of the conservation degree of species and ecosystems, considering that they are not exempt from the impacts of human activities. To identify opportunities for restoration it is necessary to evaluate the balance between deforestation and restoring natural ecosystems. The measurement of regional and local deforestation through satellite data is an emerging area, as well as the mapping of natural recovery of vegetation. Currently, there are few references of the later analysis and therefore, robust indicators to prioritize ecological restoration efforts are required. In this research I propose an algorithm to rank the temporal changes in landscape-scale forest cover, through medium resolution satellite data, and a simple index (restoration index) was proposed for ranking degradation. I evaluated the changes in vegetation cover for San Esteban National Park (northern Venezuela, 40,039 ha), over a period of 15 years, in order to define priorities for restoration. As a main result I detected that the protected area retains 70% (25,070 ha) of forests, 0.44% y-1 of deforestation (2,260 ha) and 3% of natural recovering (1,108 ha). The three most affected areas (29% of total) retain less than 50% of forest cover. The areas that require urgent restoration actions are highlighted in a thematic map.

Actividad biológica de un suelo bajo en materia orgánica frente a la aplicación de carbón de bajo rango como fuente de sustancias húmicas

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El carbón de bajo rango (CBR) al ser solubilizado produce un alto contenido de sustancias húmicas (SH) que se han aplicado como enmiendas orgánicas al suelo; se ha comprobado que ciertos microorganismos del suelo solubilizan carbón mediante enzimas, agentes quelantes, surfactantes y sustancias alcalinas. Este fenómeno permite pensar en la aplicación de CBR al suelo como una fuente de SH, cuya liberación sea mediada por microorganismos in situ. Se evaluó el efecto de la aplicación de un CBR generado en la mina “El Cerrejón” y las sustancias húmicas extraídas de este material, sobre la actividad biológica en un suelo bajo en materia orgánica. Como parámetros biológicos se analizaron el tamaño de las poblaciones microbianas, la respiración y la actividad enzimática del suelo. Las dosis más altas de CBR y EH incrementan los parámetros relacionados con la actividad microbiana del suelo. La dosis más alta de CBR no presentó efectos inhibitorios ni de fitotoxicidad en el desarrollo de las plantas. Los resultados sugieren que la adición EH y CBR mejorarían la calidad y salud del suelo, incrementando la actividad biológica, la respuesta del suelo frente al carbón es tardía y lenta mientras que con las SH se observó una respuesta temprana, hecho que sugiere el posible uso del CBR como una fuente de liberación lenta y sostenida de las SH para el suelo.

Algunas necesidades de investigación para la restauración de bosques templado-fríos de México

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Los retos para la restauración de los ecosistemas forestales de clima templado-frío incluyen, entre otros, el conocimiento de la variación genética de las poblaciones, de manera que se puedan regionalizar áreas semilleras y contribuir a que los programas de reforestación se enfocen a procedencias dentro de cada especie y a mantener la integridad genética de las poblaciones. Asimismo, es necesario un mejor conocimiento de la tecnología de producción en viveros, tradicionales o tecnificados, para la mayoría de las especies, en particular las de Quercus; igualmente, desarrollar indicadores de calidad de planta para casi todas las especies de clima templado y así contribuir, junto con una buena protección de las plantaciones, a su supervivencia. La aplicación de sistemas silvícolas con el propósito de apoyar la restauración de bosques templados es otro tema relevante, así como el conocimiento de la ecología del fuego, efectos del fuego y regímenes de incendios forestales más apropiados, pues la alteración de éstos, por exclusión o por exceso de incendios, ha contribuido a la degradación de bosques. La investigación de las dimensiones humanas de todos estos temas es crucial; como ejemplo se puede mencionar el uso del fuego, ya que algunas comunidades rurales originan incendios, mientras otras poseen tecnologías refinadas que no implican tal problema.
Reubicación de juveniles de *Espeletia grandiflora* (Asteraceae) como estrategia de enriquecimiento de áreas transformadas por pastoreo en un páramo andino (PNN Chingaza – Colombia)

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La restauración ecológica de los páramos andinos presenta diversas barreras principalmente en la fase de dispersión y establecimiento de especies nativas. En este trabajo se estudió la respuesta de juveniles de *Espeletia grandiflora* (Asteraceae) a la reubicación como estrategia de restauración ecológica; adicionalmente, se evaluó el efecto del tamaño inicial de los juveniles reubicados sobre la supervivencia y desarrollo. El trabajo se desarrolló a 3400m de altitud en el Parque Nacional Natural Chingaza – Colombia, donde se reubicaron juveniles de tres diferentes tamaños, 5, 10 y 15cm de altura inicial. Se registró la supervivencia, altura de la planta, número de hojas vivas y diámetro del tallo de cada uno de los juveniles durante dos años. La categoría de tamaño más eficaz corresponde a la de 15cm de altura con una supervivencia final del 85%. Se sugiere el uso del diámetro del tallo como criterio de selección de los juveniles a reubicar, ya que es la variable que mejor predice la supervivencia dos años luego de la reubicación, siendo proporcional a esta. El incremento absoluto en altura no presenta diferencias significativas entre los tres tamaños evaluados. La reubicación de juveniles de *E. grandiflora* presenta un efecto positivo adicional al llevar consigo otras especies que pueden contribuir al enriquecimiento y restauración del área degradada. A partir de los resultados se verifica el éxito de la reubicación de juveniles de *E. grandiflora* como estrategia de enriquecimiento, y se proporciona valores que permitirán planear y predecir con mayor certeza programas de restauración en el páramo.

**Building forest restoration strategies in the Maya-Lacandon rainforest region of Chiapas: From research to practice**

**Román Dañobetyia, Francisco; Samuel Levy-Tacher, Antonio Sánchez-González**

El Colegio de la Frontera Sur, México

The expansion of crop and pasture areas over tropical rainforest lands represent the main cause of deforestation and land degradation. In the Lacandon region, abandoned degraded lands have been considered as an important obstacle for individuals who directly depend upon an appropriate management of natural resources to maintain their traditions and to live in a sustainable way. Previous studies on ethnobotany and successional pathways derived from different vegetation use patterns by Lacandon Mayan indigenous people, were the basis for the establishment of a series of small-scale field experiments intended to obtain valuable data on plantation costs and early growth of native tree species in abandoned degraded lands. These experiments explore the effects of environmental variation and intensity of grass control on the early performance of about 40 native tree species in abandoned pastures and milpa fields. Species with diverse regional uses and ecological characteristics were chosen, including early-, mid-, and late-successional species. The goal of these experiments was to find effective and low cost forest restoration strategies in order to support the establishment of restoration plantings in degraded lands of rural communities within the Lacandon rainforest region. In partnership with El Colegio de la Frontera Sur (ECOSUR) and other governmental institutions, this restoration project has reforested up to 350 ha between 2009 and 2011 and is also leading an initiative to plant and recover an additional 500 ha throughout this region by 2013. Results, lessons, and future perspectives of research and practice of forest restoration are presented.

**Discussions on safeguard biodiversity related with EFSA NTO WG opinions on the establishment of non-target organisms that are to be observed, and elaboration of recommendations on the standardization**

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It is discussed opinions of EFSA NTO WG on the establishment of non-target organisms that are to be observed and the elaboration of recommendations on the standardization of test methods instead of simplifying and standardizing such procedures, the equivalent to what happens to pesticides (when pesticides are evaluated, their impact on non-target organisms is taken into account, for a number of species considered edifying), further complicate things, leaving place to any interpretation, subjective choices of observed non-target organisms, manipulations of certain interpretable experimental results. The proposal of EFSA NTO WG on the process of selection of species to be observed/tested does not take into consideration the fact that this selection might be subjective and difficult to put into practice, given that organisms may differ from a EU member to another, and the diversity of soil conditions,
climate, fauna, specific to a particular agroecosystem analyzed differ greatly. Referring only to the arthropods predators of insects and mites, in many cases, little about their biology is known, there are only few specialists to identify species, the structure and size of different populations, depending, of course, on the analyzed ecosystem as well as the analyzed period (years or/and periods). Details are given on the situation of the possible application of the recommendations for the specific case of Romania, emphasizing that Romania's alignment to the EU policy on GMO cultivation had a great repercussions on the national animal husbandry, also limiting the farmers' possible choice.

A socio-ecological framework for integrating research and land management in the Chicago Wilderness Region

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Chicago Wilderness (CW) is an alliance of more than 250 diverse organizations working to enhance the quality of life of residents through the conservation and restoration of ecosystems throughout greater Chicago. The prairies, oak woodlands, wetlands, and riparian zones within the Chicago Wilderness shelter several rare and endangered species and provide a variety of ecosystem services. To successfully achieve the goals of CW, including reconnecting the urban/suburban population with nature, the CW Science Team has collaborated with CW members to develop a suite of complementary projects designed to supplement existing regional conservation and ecological restoration research. The Science Team has received funding through NSF (Coupled-Human & Natural Systems and Ultra Ex Programs) for integrated biological and social research teams who are addressing complex restoration ecology questions and through the Gaylord and Dorothy Donnelley Foundation to establish over 100 long-term study plots in natural areas across the region. In collaboration with the US Forest Service, a mapping and assessment project tracks restoration, conservation, and outreach. In addition, research has targeted specific problems facing land managers. For example, understanding the effects of _Rhamnus cathartica_ on belowground systems will determine whether techniques such as soil manipulation affect establishment of this invasive species. Research initiatives presented here build upon ongoing efforts to recruit new researchers, strengthen linkages between the science and practice of ecological restoration, and foster dynamic engagement between the human and natural systems of the region.

Restauración ecológica en Argentina

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Consejo Nacional de Investigaciones Científicas y Técnicas, Argentina

La recuperación de un ecosistema mediante restauración pasiva (RP) o activa (RA), dependerá de: tipo de ecosistema, resiliencia, agente de degradación, conocimiento de la autoecología de las especies, ecosistemas de referencia remanentes y recursos. El objetivo fue categorizar los trabajos realizados en Argentina presentados en cinco congresos: 19th Conference of the SER, XIII Congreso Forestal Mundial, Congreso Ibero-Americano y del Caribe sobre Restauración Ecológica, VI Southern Connection Congress y Congreso Binacional de Ecología. Se analizó: tipo de restauración (RP, RA), objeto de estudio (animales, plantas, ecosistema), escala de trabajo (población, comunidad, ecosistema, paisaje), instituciones (universidades, universidades y otros centros, organismos técnicos u ONG) y ecosistemas. Los resultados muestran: 60% son de RP y 40% RA; 2% se realiza sobre animales, 49% en plantas y 49% a nivel de ecosistema; con respecto a la escala el 38% es a nivel paisaje, 26% a nivel ecosistema, 6% a nivel comunidad y 6% a nivel poblacional. El 65% lo realizan universidades, 22% universidades y otros centros, 13% organismos técnicos u ONG. Abarcan 10 ecosistemas: bosque templado (29%), bosque seco (18%), bosque subtropical (5%), bosque subantártico (5%), pastizales abandonados (13%), matorrales (10%), estepa (7%), monte (8%), ambientes acuáticos (3%), zona urbana (2%). Se evidencia mayor cantidad de trabajos de RP, donde se esta realizando investigación básica en relación a los ecosistemas de referencia presentes.

Approaches to Restoration Planning: Kuwait Case Study “Implementation Plan for Suliybiya Agricultural Research Station”

Roy, Waleed
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Suliybiya Agricultural Research Station (SAR) is one of the few areas in Kuwait that has been protected from grazing as of 1975. This 40 Square kilometer plot of land has been under the jurisdiction of the Kuwait Institute for Scientific Research (KISR) to carry out research projects relating to flora, fauna, biodiversity and other projects pertaining to ongoing research activities at the Institute. KISR is currently undertaking a joint venture project in collaboration with the Massachusetts Institute of Technology (MIT) to undertake the impacts of climate change on
the effects of restoration to various plant communities in SAR as part of an overall program, which will assess the long term effects on Biodiversity as well. This paper will focus on the science used utilizing prediction models developed at MIT to better understand the impacts of Climate change on the vegetation. Initially approximately 50 years of baseline data will be used to calibrate the models and then further tools, such as GIS and decision support systems will also play an essential role in the assessment and evaluation of the results.

Carbon Sequestration along the Panama Canal: From plantations to natural forests
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Carbon sequestration in tropical ecosystems is a key ecosystem service important at both the local and the international level. Local communities use forests for timber, construction, and other services while recent international agreements confirmed the mitigation potential of reducing emissions from deforestation and forest degradation. In this study, we compared the forest growth and carbon storage in mixed-species plantations, secondary forests, and old-growth forests along the Panama Canal Watershed. The old-growth forests stored more carbon than the mixed-plantation and secondary forests. However, we found non-significant difference in forest growth between the three different land covers. Both secondary forests and old-growth forests have the same percent of species use for timber; nevertheless, these species reached larger size in the old-growth forests than in secondary forests. This study emphasized the importance to maintaining old-growth forests to preserve forest carbon.

Restoration of three rare plant species in semi-arid Australia
Ruoss, Sacha; Ben Miller, Jason Stevens, Mathew Barrett, Kingsley Dixon
University of Western Australia/Botanic Gardens & Parks Authority

In Western Australia an increasing number of mining operations are being developed on banded ironstone ranges in semi-arid environments. These ranges are highly biodiverse, with a high frequency of associated rare, shallow-soil endemic plant taxa. The rehabilitation of rare plant species is therefore critical in the overall restoration of these ecosystems. A study was conducted at Mt Gibson, a banded ironstone range 350km north of Perth, which has three rare species requiring restoration (Darwinia masonii Myrtaceae, Lepidosperma gibsonii Cyperaceae, Acacia cerastes Fabaceae). The aim was to determine the effectiveness of using the soil seed bank in the restoration of these species. A total of over 6000 emergents of various species were detected from 216 soil samples taken over the Mt Gibson range from eight sites totaling 4.86m². However, 92% of the emergents were annuals; perennial species had a density of 106.17 per m². The emergent seedling density of the three rare species was 4.94 per m², 13.17 per m² and 2.47 per m² respectively. It is evident that supplementary means of plant establishment would be needed to ensure establishment of these species. Consequently, a restoration trail was established using greenstock planting on four potential restoration substrates. Results were promising, with 2-year survival of over 90% for A. cerastes and between 30-50% for D. masonii and L. gibsonii.

Altitudinal seed zones as guidelines for assisted colonization of Mexican pine populations to accommodate climate change in mountain regions
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Universidad Michoacana de San Nicolás de Hidalgo, México

Ecological restoration by reforestation with local seed sources may no longer be a suitable approach for maintaining genetic adaptation of plant populations to climate. Climate change is shifting the climates optimal for growth and survival of populations to new locations. The speed that the climate is changing will require assisted colonization, also known as assisted migration, to maintain adaptedness of native populations. Such programs are developed from models of plant-climate relationships that are used together with information on patterns of genetic variation among populations in the contemporary climate and predictions of future climates. Developing guidelines for Mexican pines is made difficult because of high diversity of this taxa, insufficient previous research information and low funding. However, no action implies larger risks and losses in the future from the sudden decline of tree populations occurring as result of a warmer and dryer climate. We suggest reforestation using altitudinal seed zones, developed based on provenance tests from populations collected along altitudinal transects, to move populations upwards in altitude (in general 300 m), in order to match estimations of climate for year 2030. Risks of frost damage on young seedlings could be minimized by using nurse plants such as Lupinus elegans, planted one year in advance. Examples for Pinus devoniana, P. hartwegii, P. patula and Abies religiosa (the latter related to the overwinter sites of the Monarch butterfly) using climate predictions for 2030 are discussed.
Dimensión científico-comunitaria del proyecto convenio de cooperación Cuba-Venezuela: “Aplicación de estrategias de reforestación, basadas en especies arbóreas pioneras, para América Latina y el Caribe”

Salazar Arismendi, Yahaira; Flores Saúl, Ramos Maribel, Hernández Laura, Pérez Pablo, Herrera Francisco
Instituto Venezolano de Investigaciones Científicas

La recuperación ecológica centra su acción en mantener la relación entre el conocimiento científico y las comunidades, con el propósito de mejorar nuestra calidad de vida, a través de la recuperación de bosques, además de unificar conocimientos y estimular la participación social en pro de reconocer nuestra responsabilidad sobre el ambiente. Este estudio, contó con aportes sustantivos en la selección de especies promisorias, hechos por las comunidades, producto de su conocimiento-experiencia local. Se realizaron talleres de reforestación comunitaria centrados en la selección de áreas pertinentes para la reforestación, selección de especies promisorias, recolección y almacenamiento de semillas. Además, se han realizado visitas a cuatro comités conservacionistas, donde se conversó acerca de los criterios de selección de especies de vivero para la recuperación ecológica. También, se elaboraron trípticos con relación a la restauración ecológica y la selección de especies promisorias para la recuperación, cuatro micros y un documental audiovisual denunciando las principales causas de la deforestación y estrategias de recuperación. Dichas actividades científico-comunitarias no solo tienen como finalidad el asesoramiento, el establecimiento de una educación ambiental en espacios formales y no formales en sentido multidisciplinario, formación de grupos académicos y comunitarios de reforestación, sino también la resolución de problemas de restauración bajo una visión práctica en áreas tropicales degradadas.

Action plan to promote fauna diversity and abundance at SECIL-Outão cement plant (Portugal): Strategy, implementation and monitoring

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Landscape recovery of SECIL-Outão cement plant quarries, located inside Arrábida Natural Park, started in 1982. In 2007, SECIL voluntarily joined European Union’s “Business & Biodiversity” Initiative with a project aiming to characterize and increase biodiversity at its cement plants in Portugal. Our presentation summarizes the results and the actions concerning the fauna component of this project. The study began with the survey of ground beetles, butterflies, amphibians, reptiles, birds and mammals in ten landscape units defined on the basis of soil type (limestone and marl), succession state (natural, post-fire) and decade of restoration (80’s, 90’s and 00’s). We found 151 animal species. Natural, burned and most recently recovered areas showed higher richness values. We concluded that prey availability is high but refuge scarcity may prevent the establishment of some species inside the property. Subsequently, this baseline data was used to define an Action Plan for fauna recovery. The Plan includes six types of actions: environmental awareness, prevention, feral animal control, vegetation management, shelter and water availability improvement. Our goal is to accelerate the ecological recovery and potentiate the occurrence of a larger community of autochthonous species. Since 2008, twenty-nine actions were applied in the field, and their effectiveness monitored. First results revealed that shelter and water availability improvement along with environmental awareness were, in the short-term, the most effective actions for the achievement of project goals. However, only long-term monitoring will allow us to be conclusive and to evaluate the real success of the Action Plan.

Socioeconomic status of Huweza Marsh inhabitants, Southern Iraq: Problems and solutions

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Most of Huweza marsh inhabitants are fishermen, farmers or working in animal husbandry. Few of them have other jobs such as drivers or security guards. All inhabitants at the best situations have a very little education level, and this may be related to the non-availability of schools and also to the poor conditions that forced children of more than 6 years old to be engaged in work. The most serious problems of Huweza Marsh inhabitants are the low and non-stable income due to low levels of production from all livelihood activities, especially when compared with the high prices of the goods they need. There is an absence of suitable transport roads between their villages and also with the main towns. Lack of basic services was noticeable especially in the irregular electric power supply and clean drinkable water supply. They face many health problems due to shortage of nearby clinics. Increased social problems led, in
The experiences of the "Atlantic Forest Biosphere Reserve" with the restoration projects at the Ribeira Valley - Brazil
Sanchez de Castro, Pedro
Instituto Amigos da Reserva da Biosfera da Mata Atlântica, Brazil

The vision of the Ecologic Restoration Program coordinated by the “Atlantic Forest Biosphere Reserve” (RBMA in Portuguese) is the increase of forest recovery at the Atlantic Forest areas in association with the principles of the MaB (the Man and the Biosphere) / UNESCO Program. The RBMA restoration projects incorporate scientific and traditional knowledge, sustainable development and biodiversity conservation inside and at the buffer zone of the protected areas. The program supports restoration efforts that reconcile conservation of biological and cultural diversity and economic and social development through partnerships between people and nature. Its purpose it to test and demonstrate innovative approaches to sustainable development from local to national scales. An example is the Rio Turvo State Park experience with a restoration project and mobilization and capacity building of the local communities at the buffer zone of this protected area. This project gives protection to the remaining forest fragments by the promoting the generation of jobs and income. In addition, the RBMA Program Restoration supports the initiatives that promote the conservation of biodiversity, maintenance and payment for environmental services, support farmers’ ability and willingness to comply with state and national legal instruments – a series of laws that have existed for many years but are still under revision. In this way, the program hosts the Executive Secretariat of the Atlantic Forest Restoration Pact, a collective movement with a formalized management structure consisting of a Coordination Board, Thematic Working Groups, and an Executive Secretariat, that are responsible for executing the strategies of the Pact.

The Atlantic Forest Restoration Pact (AFRP): Status and lessons from a Brazilian large-scale restoration initiative
Sanchez de Castro, Pedro
Atlantic Forest Restoration Pact, Brazil

Inspired by its beauty and importance, and by the urgent need to save the threatened Brazilian Atlantic Forest, and after much preliminary work, on April 7, 2009, the Atlantic Forest Restoration Pact was launched. The idea emerged in 2006 to coalesce existing efforts, integrate them in a coherent movement, and create synergies among all the actors working towards restoration and reintegration throughout the region. Today, the Pact has more than 170 members including national and international NGOs, government, private companies, and research institutions. The Pact’s vision is to integrate people and organizations to restore and reconnect the Atlantic Forest at a very large scale, and to protect the remaining forest fragments, by promoting: Conservation of biodiversity, Generation of jobs and income, Maintenance and payment for environmental services and Supporting farmers ability and willingness to comply to State and national legal instruments, and the national Forest law – a series of laws that exists since many years but is still under revision. The ambitious goal is to contribute to restore 15 million hectares of Atlantic Forest by 2050, with annual targets to be met, and ongoing monitoring, evaluation, outreach, and reporting of results to be carried out. The restoration efforts include native tree planting and other measures to promote of natural forest regeneration by removing threats that lead to degradation. During the three years of initial development of the Pact, our management structure was formalized, consisting of a Coordination Board, Thematic Working Groups, and an Executive Secretariat.

Técnicas para la propagación de especies nativas clave para la forestación, la reforestación y la restauración en el municipio de Querétaro (México) y su área de influencia
Sánchez Martínez, Emiliano; Beatriz Maruri Aguilar, María Magdalena Hernández Martínez, José Guadalupe Hernández Orío, Luis Enrique Torres Galeana, Ruth Chávez Martinez
Jardín Botánico Regional de Cadereyta, México
El municipio de Querétaro se sitúa en los 20° 35' 34.8" N y 100° 23' 31.6" O (1820 msnm). Su territorio alberga la ciudad de Querétaro, capital del estado, que ocupa más de 15,000 hectáreas. El crecimiento expandió la mancha urbana 30 veces, desde 1950. Esta expansión presiona y pone en peligro la infraestructura natural que permite la continuidad de la vida amena. La reproducción de especies clave de la flora nativa es una actividad fundamental para restaurar la vegetación perturbada. La presente investigación aporta conocimiento técnico para la propagación de 35 especies, seleccionadas mediante un índice relativizado que pondera su valor ecológico y cultural. Los protocolos son eficientes, adaptables a la tecnología practicable en la región. Las germinaciones promedian 85%, en periodos de emergencia menores a 19 días; la variabilidad de la emergencia, en las líneas de producción, medida a través de coeficientes de variación es reducida. El desarrollo después de 2 años de crecimiento en el invernadero es satisfactorio. Los métodos de multiplicación incluyen técnicas de micropropagación. Los protocolos son un instrumento agrotécnico para la conservación de la biodiversidad que incluye especies en riesgo de extinción de familias como Cactaceae, Fabaceae y Ruscaceae. Se publicó un libro con el fin de aumentar el “alfabetismo ambiental” de los queretanos para propiciar la restauración de paisajes funcionales.

Ecological restoration and environmental justice at the Limhamn Quarry, Malmö, Sweden

Sandberg, L. Anders
York University, Canada

In this paper, the Limhamn quarry in Malmö, Sweden, is explored from the perspective of ecological restoration and environmental justice. Since the cessation of extractive activities in the early 1990s, the quarry has become a site of biodiversity and refuge for endangered species. City ecologists have fought successfully to designate the Limhamn quarry as a nature protection area. At the same time, the area surrounding the quarry has become a zone for exclusive condominium development; the quarry is also marketed by the city and developers as an “urban spectacle”, Sweden’s “Grand Canyon”, that is part of putting Malmö on the world map as a major tourism and investment destination. The paper explores the quarry in the context of a restoration discourse of two exclusionary zones, or “gated communities”, one natural and one social, with real and potential environmental justice consequences. The boundary between the quarry and the surrounding condominium development does not only separate, it also unites and subjects different land uses to similar terms and conceptions that reinforce rather than challenge each other. At the same time the common restoration discourse at the quarry may obscure the possibility of thinking of and developing restoration initiatives for marginalized groups both at the quarry and in other places. The paper closes by exploring the prospects of providing public access to the quarry as well as the broader implications for ecological restoration efforts more broadly as a result of focusing attention and resources at specific high-profile and highly publicized sites.

Discovering the symbiosis between traditional Cherokee and Celtic ecological lore and present day efforts to conserve and restore natural communities in the Southern Appalachian

Schewe, Jeremy; John Myers, Jackie Dobrinska
Falcon Engineering, Inc., USA

The Southern Appalachian Mountains are geologically and physically isolated from the surrounding region. Industrialists have viewed this isolation as an impediment to progress, harboring slopes too steep to log and land owners resistant to enculturation and consumer culture. Conservation and preservation of diverse ecological areas were enabled by this inaccessibility. Many of these areas are now contained within recreation areas, national parks, and cultural heritage areas. Due to isolation and cultural defiance, the region is also a cornucopia of traditional ecological lore, much of which has been lost in other developed areas. The Eastern Band of the Cherokee managed to hide-out in the inaccessible mountains, thereby reclaiming some of their ancestral homelands, while immigrating Celtic Scotts and Irish were able to reestablish their well-loved freedom and autonomy. This presentation will demonstrate how Cherokee and Celtic ecological lore are cultural codices enriching current eco-communities and acting as guideposts for humans to better live in a balanced and sustainable way. Each codex contains the mystery of the landscape, its natural wonders, its treasure trove of natural remedies, and guidance to ethical human relations in respect to the natural environment. These ancient traditions have been incorporated into community design and pattern language, enabling a contemporary, balanced model. Annual festivals respecting the seasonal landscape encourage people to become immersed in restorative socio-ecological practices. In addition, this presentation shows how Celtic and Cherokee ecological lore have influenced contemporary art, music, planning, development, ecologic restoration, and design of homes, neighborhoods, and communities.
Snake hollow watershed restoration, acidic water mitigation, and abandoned coal mines closures
Schewe, Jeremy
Falcon Engineering, Inc., USA

The Snake Hollow Watershed is located in Wayne National Forest in the Appalachian region of eastern Ohio. Snake Hollow is part of and drains to the larger Monday Creek Watershed. The project area is characterized by former subsurface coalmine operations and partial strip mining operations. Subsurface mining began at the site in the early 1900’s. As coal pillars and the roof of the old mine shafts age, many have collapsed, causing the secondary growth woodlands to subside in several places, diverting water flow into mines where it becomes acidic due to concentration of heavy metals. As a result, the water quality of the streams and wetlands in Snake Hollow was poor and supported little if any aquatic life. Our group was tasked with initiating mitigation measures that would allow restoration of the water resources in the area and consequently improve water quality downstream. Streambeds were prepared by removing the surface vegetation, stone, and soils (later used as filler and surface materials) and then lining the streams with limestone rock riprap that would act as a buffering agent to mitigate the acid water conditions. Existing acidic water flows over the limestone riprap and slowly dissolves the limestone resulting in a closer to neutral pH of the stream before it merges with Monday Creek. Invasive species along streams and wetlands were cleared and grubbed. Mine shaft openings were plugged and closed to prevent further surface collapsing. The project was completed by reseeding the area with native plants and temporary herbaceous cover.

Challenges for seedling production for forest restoration in Ocean Island: The case study of protected areas of Fernando de Noronha/PE – Brazil
Schiavon Machado, Manoela; Pedro H. S. Brancalion, Carolina de Moraes Potascheff
Project TAMAR/ESALQ University, Brazil

Since its discovery, in 1503, the island of Fernando de Noronha has suffered innumerable anthropogenic disturbances, and degraded terrestrial areas are nowadays part of its landscape, despite the beauty of its sea ecosystems. During the period the island was used as a presidium, the largest trees were cut in order to avoid the escape of prisoners by boats. Inserted in this scenario, the present study sought to investigate the phenology, seed germination, and seedling establishment of native species of the Atlantic island of Fernando de Noronha, Brazil. The main island of Fernando de Noronha was studied through tracks, where phenological data of 20 native species of trees and bushes were collected every fifteen days. Mature fruits of the same species were collected from the most preserved areas and taken to the forest nursery where pre-germinative treatments on the seeds were tested. The seedlings were planted in an area of 1 hectare and had their development accompanied individually. It was possible to identify, based on phenological data, the species locations and periods of fructification. The different treatments applied on the seeds provided improved germination consistently, which varied from 8% to 90%. In the field area, it was observed an average of 70% rate of seedlings survival. In spite the climatic and edaphic difficulties encountered in ocean islands, seed and seedling production, as well as the initial establishment of seedlings in the field, were successful in Fernando de Noronha, which shows favorable perspectives for forest restoration even in isolated oceanic islands.

The Leslie Street Spit: Ruins of a city and its surrounding landscape
Schopf, Heidy
York University, Canada

The Leslie Street Spit is a five-kilometre long, manufactured landscape that juts out into Lake Ontario. Composed of construction rubble and lake dredgeate, the Leslie Street Spit is the cumulative result of over sixty years of dumping waste into Lake Ontario. Currently, the Spit is known for its ecological success given its history of ecological restoration and rehabilitation, and is celebrated as the site of Toronto’s urban wilderness. While the ecological importance of the Spit cannot be denied, the underlying nature of this landscape is one that reflects the development and destruction of the City of Toronto and its surrounding landscape. Recognizing the nature of the rubble and tracing it to its source locations in the city and beyond allows for a full appreciation of the history and meaning of this landscape. This research finds that the rubble of the Leslie Street Spit is the result of the creative destruction of Toronto since it is the elements of the city that were discarded so that Toronto could become a modern, and in turn post-modern, city. This research also establishes that the source locations of the rubble reflect the long term process of landscape domestication in southern Ontario, which is associated with the aggregate production cycle. Assigning context to the rubble of the Leslie Street Spit transforms the discarded brick and concrete from unidentifiable waste to the ruins of Toronto where the connotations of this landscape are fully appreciated.
Phylogenetic ecology applied to tropical forest restoration

Schweizer, Daniella
University of California, Santa Cruz

A common strategy to diversify tree plantations on former agricultural lands in the tropics is enrichment planting with a suite of mature forest species that rarely colonize on their own. Usually species are selected for enrichment planting based on availability or previous knowledge of seedlings performance without considering evolutionary relationships between the canopy and the seedling species. Species closer to each other in the evolutionary tree often share ecologically important traits that determine their performance in a given environment, but this idea has not been applied yet to a restoration framework. I tested whether there is a phylogenetic signal in the performance, measured as growth and survival, of planted tree seedlings depending on their evolutionary relationship to the overstory tree species under which they are planted. I planted the understory of 33 single-species plots in the Panamanian lowlands with seedlings that ranged in their evolutionary relationship to the overstory (from conspecifics to distantly related). I measured growth and survival for two years. My results show that tree seedlings grew more and survived significantly better when they were less related to the overstory, but this result was mainly driven by the conspecifics. Both survival and growth were also strongly affected by the seedling identity. These results suggest that species identity is the overriding factor in determining performance. Regarding phylogenetic relationships, seedlings should not be planted under the canopy of conspecifics; otherwise, this variable is not a strong predictor of seedling performance.

Fresh sparks and eureka’s

Scott, Richard
National Wildflower Centre, UK

The Keeping Eyes Wide Open workshop towards the end of the Merida conference will be consulting the conference audience, in an unusual way, to show that new processes of dialogue and approach can transform attitudes to raise awareness of the benefits of using creative ideas and actions to stimulate interest and excitement in the practice of ecological restoration. This presentation will spell out the background of creative approaches, to stimulate and magnify interest in the important message and action of ecological restoration in the world. After successfully staging a similar workshop at the SER conference in Avignon in 2011; the importance of reaching out to communities and non-traditional conservation audiences, was made clear by the Production of a Statement for Social Action, as conference outcome. The aim therefore is to build on this effort by engaging the Merida participants in a fun and thought provoking exercise. By linking to the conference’s broad audience and experience of participants we may reveal fresh insights and approaches to the way we work with people and so help secure a serious niche for the practice of ecological restoration in the societies we live in. The participants of this session will be invited to become volunteers in the process of vox popping the conference participants in a mysterious and entertaining way.

Earthworms and ecosystem function

Scullion, John
Aberystwyth University, UK

Earthworms play a key role across a range of important soil functions, in seedbank dynamics and in the broader ecosystem food chain. In many degraded ecosystems, earthworm populations are greatly diminished and their species composition impoverished. Natural recovery in populations is often slow and this constrains broader ecological restoration objectives. Evidence will be presented in support of their roles in ecological restoration, on strategies for promoting population recovery, on the effects of earthworm activity on soil physical regeneration, on carbon dynamics and on interactions with plant roots and soil micro-organisms. The main focus of this evidence will be on land degraded after mining but its wider relevance to ecologically degraded agricultural soils will also be considered.

Ecosystem restoration and conservation in the lower Senegal River Delta: Case of Diawling National Park

Sehla Daf, Daef
Diawling National Park, Mauritania

The wetlands of the lower delta of the Senegal River were recognized as being among the most extensive and richest in West Africa until the early 60s. However, these ecosystems have undergone substantial changes since the 70s
under the combined impact of climate variation (drought) and construction of two dams. This is why the government of Mauritania decided, in 1991, to set aside 16,000 ha of the former floodplain as Diawling National Park. It has been a Ramsar site since 1994 and is included in the Trans-Border Biosphere Reserve of the Senegal River delta. The resident populations have been integrated as an essential component of the park and as partners in managing its operation. The park has striven hard to recreate “pre-dam” conditions in the various basins by building new dykes and works to supply fresh water artificially from the impoundment of the Diama dam itself. Gradually, the characteristic vegetation of the lower delta has been re-established, in particular species important for local communities. Thousands of mangroves are also colonizing the bottomlands of the Ntiallakh basin. The park’s ponds serve as breeding and spawning grounds for many freshwater and estuarine fish; fishing catches are high. Through technical and financial assistance, fishermen have been organized and formed into co-operatives, supported with gear and equipment. The park hosts large flocks of waterfowl and migratory and resident birds and several nesting species have also been seen returning.

**Compatibility of non-energy mineral extraction in protected natural areas (Europe Natura 2000): The case of restoration regulations in Catalonia**

**Serra, Esteve**  
Government of Catalonia, Spain

Since 1981 Catalonia (NE Spain) has a specific law for the rehabilitation of protected natural areas affected by mineral extraction activities. Subsequent European, Spanish and Catalan regulations have complemented this law, establishing the legal body responsible for the protection and restoration of the spaces affected by extraction activities. Experiences and results obtained over 30 years confirm the value of legal and technical criteria established by this normative. These experiences have been presented to the European Commission (EC) working group entrusted to the study of the combination of non-energy mineral extraction with Natura2000 (European network of protected natural areas) objectives. The result of this process, developed between 2008 and 2010, is the recent publication of the EC guidance on undertaking new and non-energy extractive activities in accordance with European Union nature legislation. The comparison between the management model applied in Catalonia and the proposals of the EC guidance document allows validation of the principles and criteria of the Catalan legislation. According to the Directive 92/43/CEE an appropriate assessment should be incorporated into the mandatory environmental impact studies of the extraction activities carried out on Natura2000 areas.

**Understanding management of invasive species using disturbance-based methods: The links between invasion, disturbance, and biodiversity loss**

**Shackelford, Nancy; Michael Renton, Michael Perring, Kristine Brooks, Richard Hobbs**  
University of Western Australia

Human population expansion and economic development threaten worldwide biodiversity through habitat loss, resource depletion, land use change, and disturbance regime shifts. In this presentation, we focus on kwongan, a sandplain heath system in Western Australia. Kwongan heathland contains immense floristic biodiversity and endemism. Currently, there is concern from land managers that this biodiversity is slowly being lost, even in relatively pristine areas. To quantify this hypothesized loss, we updated 1983 floristic surveys describing a local nature reserve. We repeated those surveys in 2010 and assessed species loss and decreases within functional groups. We found that losses occurred almost uniformly over functional types. The results were analyzed for relationships with environmental variables, including invasive species density, disturbance, and site attributes. We determined that highest rates of loss were on sites experiencing high densities of a native invasive tree. Subsequently, we constructed a population model of the invader. Our goal was to predict how various fire regimes and tree removal would affect population density over time. We used the biodiversity data to estimate a relationship between tree density and reduction in heathland diversity, which allowed us to translate model predictions into potential biodiversity impacts and thus to identify management options likely to maintain target biodiversity levels. We found no apparent threshold of state change from heath to tree canopy; more frequent fires controlled the invader without managed removal. The regularity of fire did not affect rates of density increase, allowing primary consideration for heath health in fire management planning.
**Strategies for post-wildfire re-establishment of Wyoming big sagebrush communities in the Great Basin, USA**

Shaw, Nancy; Mike Pellant, Robert Cox, Ann Hild and Megan Taylor
USDA Forest Service

The cycle of wildfire and annual weed invasion has degraded vast areas of Wyoming big sagebrush (*Artemisia tridentata ssp. wyomingensis*) in the western United States, disrupting ecosystem functioning, altering fire regimes, and reducing biodiversity. Successful revegetation of these communities is difficult. We examined approaches for re-establishing Wyoming big sagebrush and associated understory species following a 2008 wildfire in northeastern Utah. Treatments tested two drills, the standard rangeland drill and a minimum-till drill on 0.2 ha plots. Large seeded species, primarily grasses, were seeded in alternate rows. Small seeded species, including sagebrush, were broadcast seeded through the drill in intervening rows and covered (drill broadcast) or hand broadcast to simulate aerial seeding. Treatments were a control and six treatments for each drill: fall drill, no seed (to simulate seeding failure); fall drill grasses and drill broadcast small seeded species with sagebrush at a standard, 5X or 10X rate; and fall drill grasses with hand broadcasting of small seeded species (5X sagebrush rate) in fall or over snow in winter. With good precipitation in 2009 and 2010, grasses established successfully with all drill seeding treatments and reduced biomass of the exotic annual halogeton (*Halogeton glomeratus*) by about 80% in 2010. Small seeded forb establishment was increased when seeded with the minimum-till drill. Sagebrush establishment was improved only with the 10X seeding rate. Establishment of Wyoming big sagebrush communities remains problematic due to low and erratic precipitation; but improved seeding equipment and strategies reduce the risk.

**Resilient landscapes, resilient institutions: IUCN’s experience in the last four years**

Shepherd, Gill; Li Jia, Lucy Emerton, Tawatchai Rattanasorn, Bob Fisher, Clarisse Honadia
IUCN Commission on Ecosystem Management

Among the 24 forest landscapes/ecosystems which IUCN has worked on in its ‘Livelihoods and Landscapes’ programme, three in particular stand out for their restoration efforts. These are the Miyun watershed above Beijing, which provides 80% of Beijing’s water supply; the Doi Mae Salong watershed in northern Thailand, in an area degraded and chaotically cleared over decades by immigrants from China, Burma and other parts of Thailand; and the Sablogo forest in Burkina Faso in Sahelian Africa, an area into which environmental refugees from drier areas further north have been migrating, with their herds. In each case, it has been possible to reverse degradation and to initiate restoration through natural regeneration, planting and more active management. In each case, as well, plans for the increased resilience of the resource in the future have been made. The work has involved choosing forms of restoration which make technical and ecological sense, but which are assured by building in greater socio-economic and institutional resilience at the same time. None of these examples take place on private land, and the institutions, or networks of institutions which carry out the initial restoration work become the drivers for continuity and sustainability into the future. Collaboration in each case has involved people who live in the location, government employees and external facilitation in the early stages which becomes internalised over time. Longer term resilience grows from a combination of local and external expertise, and from support for local on-the-ground institutions.

**Vegetation characteristics modify interactions among soil ecosystem services during tropical dry forest recovery**

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Following tropical dry forest conversion to agriculture, regulating ecosystem services are frequently lost, including groundwater recharge, mitigation of floods and greenhouse gas emissions. However, after several years of agricultural production, even provisioning services widely decline, including the capacity to produce food, fibre, fuel, medicines etc. Thus, there is potential interest for different stakeholders to restore multiple services. In order to facilitate restoration of multiple services, it is necessary to understand how the vegetation modifies tradeoffs and synergies among services. We aimed to integrate multiple ecosystem functions that are fundamental to a range of regulating services along a chronosequence of tropical dry forest regeneration on the Pacific coast of Mexico. Using structural equation modeling (SEM) we evaluated the chain of effects of vegetation characteristics via litter fall, litter mass and composition, and soil microbial community structure on key soil ecosystem functions, including nutrient availability, atmospheric N2-fixation, soil carbon storage, soil aggregation and porosity. These soil functions
underpin the restoration of regulating services, including soil productive potential, climate change mitigation, as well as soil physical functions which regulate soil erosion and the hydrological cycle. We integrated these effects of vegetation structure, diversity and composition on regulating services with the potential direct uses of woody species in the same chronosequence plots by local managers of secondary vegetation.

La educación ambiental en tiempos modernos: Reflexiones sobre sus intenciones y su esencia
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Universidad de Guadalajara, México

A pesar de la reciente actividad dirigida a la crisis ambiental, las estrategias y políticas hoy, suelen mostrar vacíos y/o escasez en la práctica orientada a la formación de una conciencia socioambiental. La Educación Ambiental (EA), como movimiento esperanzador crítico-reflexivo; supone la construcción de una nueva ética individual y colectiva en contraste a los estilos de vida modernos, reproducidos en uno de los espacios clave para el desarrollo de un país: la escuela. La transición que ahora sufre esta disciplina, -en el reciente Decenio de las Naciones Unidas de la Educación para el Desarrollo Sustentable (2005-2014)-, pone de relieve los objetivos de un Desarrollo Sustentable que corre el riesgo de seguirse estancando en la lógica de mercado; donde lo material y la competencia son símbolo de bienestar. En este sentido, se propone una reflexión en torno a la intención y esencia de una ética ambiental – que incluya la realidad social latinoamericana – y parte de contextos locales donde la conservación y restauración resultan insuficientes sin el complemento de una sociedad educada. Haciendo énfasis en los círculos urbanos, es preciso apuntar no solo a las generaciones futuras, sino a la crisis de un presente ligado a nuestras relaciones cotidianas con la naturaleza, con nuestra sociedad y con nosotros mismos.

Small fauna, fast response: Using small mammals to access quarry recovery measures and vegetation succession in a short period of time
Silva, Carmo; A. Galantinho, P. Salgueiro, T. Mexia, F. Carvalho, D. Medinas, A. Silva, J. Gusmão, A. Mira
Universidade de Évora, Portugal

Vegetation removal is one of the most direct impacts of quarries on faunal communities. In 1982, SECIL-Outão cement plant started a quarries landscape recovery program and in 2008 implemented an Action Plan (AP) aiming to increase fauna diversity and abundance in the recovered areas. Vegetation characteristics limit small mammal abundance. Therefore, these species are suitable indicators of vegetation state and respond to its changes in short periods of time. Our study aims to evaluate small mammal abundance in different landscape units corresponding to natural and recovered quarry areas in a three year span. Simultaneously we evaluated the effectiveness of a measure aiming to improve small fauna shelter in recovered areas were we believed to exist a high predation pressure by feral animals. Ten different sampling areas were chosen, five for each soil type (limestone and marl): areas recovered since 80’s, 90’s and 00’s decades, burned and natural habitats. In 2007 (prior to the implementation of the AP) and 2010 (after AP started), small mammals were live-trapped. Abundance was calculated as capture success index. Variables related with vegetation characteristics were also assessed. Multivariate and paired comparison statistical analyses were performed. Apodemus sylvaticus and Crocidura russula were caught mainly in limestone natural areas, while Mus spretus was more abundant in areas recently recovered, with higher herbaceous cover. Differences in small mammal communities between years were most probably related with vegetation succession and direct changes in some of the studied areas. Shelter improvement revealed to be an effective way to increase small mammal.

How can we restore to maximize seed dispersal rates by birds in Brazilian rainforests?
Silva, Wesley
Universidade Estadual de Campinas, Brazil

Frugivores comprise a high valuable functional group in restoration sites, contributing to the arrival of new plants and to the dispersal of the planted ones. However, bringing frugivores into restored sites may be hampered by many environmental filters that can impair the full reestablishment of this guild and its potential contribution to seed dispersal. Atlantic forest restored and regenerating sites show that communities of frugivorous birds occupying forest fragments and planted areas can occur side by side in a small geographical scale, but frugivores in restored habitats are usually an impoverished subset of the forested ones. Filters that preclude the recolonization of the whole set of frugivores into planted or regenerating sites could be related to vegetation features, like fruit size, tree height and understory layer. Seed traps in a restored site in southeastern Brazil collected more allochthonous (non-planted) than autochthonous (planted) species, mostly from small-sized fruit plants. Behavioral observations also suggested
that frugivores were unable to consume large-sized fruits. Undergrowth shrub species were usually absent and so were small important undergrowth frugivores. Among the planted ornithochorous tree species, most were ignored by frugivores and only a few comprised the bulk of interactions with birds. In a spontaneous regenerating site nearby, richness and abundance of seed rain was positively correlated with tree height. Improving bird seed dispersal rates in restored habitats may thus require the management of floristics and vegetation structure, supported by bird diet and behavioral data.

Win-win restoration: Estimating benefits to the environment, culture, jobs and the economy

Skrabis, Kristin
US Department of the Interior

In this era of high unemployment and increasingly tight budgets, “win-win” restoration seeks to tell a more complete story of the benefits of restoration. Restoration of ecosystems, cultural services, recreation, and commercial activities provides broad value. Economics can help decision makers understand this value, along with the jobs and economic impacts that result. While there may not be a universally accepted definition of ecosystem services across disciplines, ecologists’ classification of provisioning, regulating, supporting and cultural services aligns with the economic concepts of use and non-use values. Using the context of the US Department of the Interior’s natural resource damage assessment and restoration (NRDAR) program, an overview of economic tools to value restored ecosystem services and measure the resulting restoration economy is provided. The NRDAR Program restores natural resources injured as a result of oil spills or hazardous substance releases into the environment. In partnership with other affected state, tribal, and federal trustee agencies, Interior evaluates injury to natural resources, including adverse effects on biota, soil, water, and air. The damage determination phase of the NRDAR process establishes the necessary compensation to restore the loss of the resource experienced by the public. Economic tools used on damage assessments are described in the Title 43, Part 11 of the US’ Code of Federal Regulations.

Influence of watershed-scale pesticide management on channelized agricultural headwater streams

Smiley Jr., Peter; Kevin King, Robert B. Gillespie, and Norman R. Fausey
US Department of Agriculture

Channelized agricultural headwater streams are streams that have been created or modified for agricultural drainage. Elevated pesticide concentrations frequently occur within these modified streams and represent a threat to their ecological integrity. Pesticide management (i.e., use of alternative herbicides, crop rotations, reduced herbicide use) is intended to reduce pesticide concentrations within agricultural streams. Yet, the influence of pesticide management on channelized agricultural headwater streams has not been empirically evaluated. We used a before-after-control impact design to evaluate the influence of watershed-scale pesticide management targeting atrazine on the water chemistry and stream communities within channelized agricultural headwater streams in central Ohio. Water samples for nutrient and pesticide measurements and stream communities were collected during the spring and summer over a five year period from a treatment stream that initially received pesticide management (2006, 2007) and then did not in the last three years of the study (2008-2010). We also sampled water chemistry and stream communities within a control stream that did not receive pesticide management. Our initial results found that pesticide management reduced the frequency of atrazine occurrence and the number of pesticides, but it did not reduce the mean concentration of atrazine or deethylatrazine. We also observed pesticide management did not influence fish species richness, abundance, evenness, or the percentage of headwater fishes captured. Our preliminary results suggest watershed-scale pesticide management has the potential to contribute to watershed restoration projects through its water chemistry impacts, but its effects on stream community structure appear limited.

An experimental approach to re-establishing Florida scrub: Results from five years of active restoration on abandoned pastureland

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While abandonment of agricultural lands provides opportunities to restore historical landscapes, restoration actions may require efforts beyond standard land management depending on the degree of degradation. To assist land managers in their restoration techniques, we conducted a series of experiments to develop science-based guidelines for re-establishing Florida scrub, a rare pyrogenic shrubland hosting over 100 endemic plant and animal species. Our research focused on recovering critical components of Florida scrub (e.g. increasing bare sand, decreasing exotic plant cover, introducing important plants) on pasturelands previously grazed for >30 years. Treatments, studied in six
50-m radius macroplots, included annual herbicide applications to remove exotic grasses and three separate reintroductions of foundation scrub plants. Treatments were designed experimentally to evaluate restoration methods and test ecological hypotheses. While initial survival (<1 year) of introduced propagules was high (>75%), longer-term (1-3 year) establishment was <50%. By following demographic performance we found survival and growth were influenced by competition from exotics, soil moisture, functional group, and propagule type. Vegetation structure and composition were monitored within 24 5-m radius plots embedded in pasture (i.e. restoration) and reference scrub macroplots. After five years of treatments, exotic plant cover has significantly decreased (74.0% to 45.5%) while native species richness and bare sand cover increased (9.3% to 19.9%), thus moving restoration plots toward reference conditions. In addition to providing habitat for imperiled scrub endemics, our results identify factors that will assist in future restoration of degraded Florida scrub.

**How landscape scale biogeochemical processes affect the restoration of groundwater fed wetlands:**

**The sulphur bridge**

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It becomes increasingly clear that, even in areas were external nutrient loads are considerable, increases in external nutrient loads alone cannot explain the eutrophication of wetlands. Eutrophication of surface waters, as a result of changes in water quality without external input of nutrients (N, P, K), is called ‘internal eutrophication’. Increased sulphate loads appear to play an important role in this process. In large parts of the world, excessive use of manure and synthetic fertilizers results in leaching of nitrate from agricultural lands. Once it accumulates in groundwater, nitrate causes chemolithotrophic oxidation of geological pyrite deposits in the subsoil. In this way leaching of nitrate from agricultural lands can result in greatly increased sulphate concentrations in groundwater and, after discharge, also in surface waters. Next, as long as groundwater nitrate concentrations are high, ferrous iron concentrations tend to remain low as nitrate prevents iron reduction in the sub-soil. Therefore, high nitrate loads can also strongly decrease groundwater iron concentrations. The increased input of sulphate and decreased input of iron in (groundwater fed) (semi)aquatic ecosystems can lead to a decrease of the capacity of the wetlands soils to retain phosphorus which results in a strong eutrophication of such systems. This shows that, to understand abiotic conditions of an individual wetland, understanding of landscape-scale hydrological and biogeochemical processes may be essential. Restoration and management of wetlands should therefore be approached at a broader scale which includes the landscape-scale management of groundwater systems.

**Restoration of biodiversity on degraded lands by using Indian Traditional Knowledge in sub-Himalayan region**

Sood, Sanjay; Nandita Gupta, Shikha Mehra, Rakesh Kumar

Indian Forest Department

In ancient India, concepts of Village Forests and Sacred Groves were very much interwoven in the tradition. The people worshipped trees like *Ficus religiosa* & *Ficus bengalensis* & treated them as incarnations of gods & respected the codes & ethics for protection of forests. However, in modern times, over-population pressures & commercialization eroded this complimentary man- forest relationship leading to severe degradation of forest lands. This case study undertaken in Hamirpur, Himachal Pradesh, India highlights the efforts made to reverse the trends of decreasing tree cover in Village Common Lands, rendered fallow otherwise by People's Participation. Awareness was created by delivering structured talks & presentations based on religious texts (Vedas, Ramayana, Bible, and Quran) highlighting the economic uses besides the environmental and astrological benefits of various trees. These texts suggest trees to be planted to ward off diseases/evil effects of malefic planets. People were encouraged to plant trees, provided by the Forest Department, of their choice at the end of each awareness camp. These efforts with the help of local NGOs and various Self Help Groups met with a resounding success. Over 35,000 tall saplings of 37 local species were planted voluntarily in about 100 acres of land distributed over 20 villages by 3,000 people during the year 2007-08. The survival rates have been as high as 90% over the period. Such efforts, besides serving as a model for rehabilitation of fallow lands, is expected to give a big boost to Indian traditional systems of medicine.

**Educational requirements for the certification of practitioners of ecological restoration**

Stanley, John

Society for Ecological Restoration
The Society for Ecological Restoration (SER) Ad-hoc Certification Committee has been working on the development of the SER Practitioners Certification Program (PCP) since 2008. I will describe the process and rationale for the development of the Educational Achievement requirement for the SER PCP. I will provide an overview of the background research associated with the development of the Educational Achievement requirement including: 1) Standards of Practice (SOP) Survey, 2) review of the educational requirements of 15 certification programs in related fields, and 3) Dr. Nelson’s review of the academic requirements of college and university programs in ecological restoration and restoration ecology. I will explain the point system that allows applicants flexibility in meeting the Educational Achievement requirement by combining points for academic degrees (Credential Points) and points for knowledge in subject areas related to restoration (Knowledge Points) which are based on “instructional contact hours” thereby allowing candidates to combine points for academic coursework with points for short-courses and workshops taken since graduation. I will also address the eight “essential subject areas”, seven “highly recommended subject areas” and five “additional beneficial subject areas” and the specific point requirements for each of the “essential subject areas” which vary depending on the level of certification. Finally, I will discuss the importance of developing a practitioners “Body of Knowledge” which identifies desired learning outcomes and can serve as the basis for a “job/practice analysis” for the field of ecological restoration eventually leading to the development of “occupational standards” for the profession.

The dilemma of protected areas management in an era of rapid global changes

Stephenson, Nathan
US Geological Survey

Management policies for protected areas (such as national parks and wildernesses) often direct natural resource managers to restore and maintain naturally-functioning ecosystems. However, in the face of rapid, interacting global changes this management direction poses profound challenges. What is “natural?” How does one maintain naturalness when future environmental conditions are expected to have no analog in the past? Has the concept of naturalness lost its value? Naturalness in the sense of historical fidelity (conditions as they were before the advent of modern technological society) will almost certainly become impossible to maintain. On the other hand, naturalness in the sense of freedom from intentional human intervention will remain possible, but may be undesirable if accompanied by the threat of sudden, catastrophic loss of native biodiversity or key ecosystem functions. Thus, impetus for management intervention may be high. However, precise characterization of appropriate management interventions and desired future conditions for protected areas will be confounded by (1) the unprecedented nature of environmental changes (meaning we will have no precise reference analogs in the past), and (2) the unpredictability of future environmental and biotic changes at spatial and temporal scales useful for management. Managing for ecosystem resilience may be useful not as a desired end in its own right, but as a means of buying time while a range of adaptation options are explored and implemented.

Cultural and ecological resiliency in the Tigris-Euphrates watershed

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Lowered discharges from the Tigris Euphrates Rivers through the Shatt Al-Arab River into the Arabian Gulf have precipitously altered the cultures and ecosystems throughout the Twin Rivers watersheds. The fate of the Mesopotamian marshes cannot be separated from the Tigris and Euphrates watersheds; therefore, this presentation will take a holistic perspective, analyzing upstream dam construction and water diversions on the hydrology, biodiversity and social justice throughout the watersheds. For ten years I have worked with the cultural and ecological restoration of the Mesopotamian Marshes. Last summer I toured the upper watershed of the Tigris and Euphrates Rivers in Turkey, observing proposed new dam construction impacts on Turkish and Kurdish cultures and ecosystems. In Turkey, reservoirs created by dam construction are displacing local human populations and drowning irreplaceable archaeological sites and wildlife habitat. Upstream water diversions are proving to be a threat to cultural and ecological justice for inhabitants of the entire watershed. The rivers and marshes are a culturalized landscape, formed over thousands of years by agricultural and traditional management. From the headwaters to the Gulf, each region has unique stories, poetry and songs. The marshes provide a nursery for fish and shrimp production for the Gulf; providing wintering habitat for millions of migratory birds; sustaining regional diversity of plants and animals; and improving regional water quality and microclimates. This presentation will provide a forum for cultural and environmental information exchange throughout the watershed, with the goal of developing a network to develop solutions for equitable water rights allocation.
Genetic delineation of local provenance in *Persoonia longifolia*: Implications for seed sourcing for ecological restoration

**Stingemore, Jessica; Siegfried Krauss**
University of Western Australia/Botanic Gardens and Parks Authority

Restoration of diverse native plant communities typically requires the collection of large amounts of seed. Thus, practitioners often struggle to find adequate supplies near project sites and need to know how far they can range for collections without compromising restoration success – that is, how far does local provenance extend? We addressed this issue by assessing genetic variation within, and differentiation among, twelve potential seed source populations of *Persoonia longifolia*, a key component of the understorey of the Jarrah Forest of southwest Western Australia. An AMOVA analysis of 66 polymorphic AFLP markers partitioned 92% of the total genetic variation within populations and 8% among populations, indicating significant but relatively weak genetic differentiation among the sampled populations. Genetic differentiation among the sampled populations, assessed by non-metric multidimensional scaling ordination, showed marked west/east and north/south gradients. The global significance value from ANOSIM (R = 0.14) correlated to a general provenance distance of 50 km. To detect signatures of natural selection, a Spatial Analysis Method (SAM) was performed, which assessed associations between AFLP marker frequencies and each of five climatic variables using multiple univariate logistic regressions. Two markers were significantly associated with the climatic variables potential evapotranspiration, solar radiation and minimum temperature. Frequency differences at these markers across populations revealed distinct geographic provenances. Guidelines for seed sourcing that consider these population genetic data should lead to more efficient and effective ecological restoration with this species.

Using patterns of faunal recolonisation to improve restoration practices in the Jarrah Forest of South-Western Australia

**Stokes, Vicki; Mike Craig, Richard Hobbs, Giles Hardy**
Alcoa of Australia

Alcoa has been mining bauxite and restoring mine-pits in the Jarrah Forest of South-Western Australia since 1966. Over that time, restoration practices have been continuously improved leading to present day practices that involve contour ripping, direct topsoil return, hand-planting of recalcitrant species and the provision of logs and rocks as fauna habitat. These practices have been largely effective in facilitating faunal recolonisation yet there are still species that fail, or rarely, recolonise restored mine-pits. We used trait-filter models to identify probable barriers to faunal recolonisation and to suggest modifications to restoration practices that would remove, or minimise these barriers. Species that failed, or were slow, to recolonise fell into three groups that shared ecological traits: a group of three reptiles that were dependent on logs; a group of three birds that required mature trees for canopy foliage, thick branches and/or fruit; and a third, less expected group of one reptile and one bird that require the open understorey and canopy typical of unmined reference sites, but that are generally absent from mine-pits. The reptile from this last group also demonstrated that filters can be temporally dynamic so the return of a species does not necessarily mean it will persist. In summary, there are three main filters to faunal recolonisation in Alcoa’s mine-pits; a paucity of logs, slow growth rates of trees and the establishment of too much vegetative cover. Management practices that aim to remove the effects of these filters will facilitate greater faunal recolonisation and potentially lead to greater ecosystem resilience in restored mine-pits.

Differential landscape filtering between adults and young birds in Amazonian rainforest fragments

**Stouffer, Philip; Erik Johnson**
Louisiana State University, USA

Recovery of rainforest bird communities in small forest fragments and developing second growth depends first on colonization from larger forest patches, followed by establishment of populations. In Amazonia, we can reliably detect species, but we are rarely able to infer population processes. Recent advances in aging Neotropical birds have allowed us to examine differences between adults and immatures in movements through second growth and residency in small fragments for a subset of rainforest understory birds near Manaus, Brazil. Second growth burn history, which strongly influences bird movements in the first few years, matters little in >20-year-old second growth. In most species, immatures respond more to second growth age and distance to continuous forest than do adults, which are more associated with fragment size. Immature frugivores, in particular, readily move throughout the landscape. Some of these birds are undoubtedly produced in continuous forest, but these species probably also
breed in small fragments or second growth. For ant-followers, immatures regularly move through second growth >15 years old, while adults are much more restricted to continuous forest. Immature flock insectivores sometimes colonize fragments through >20 year old second growth, although adults do not. These results suggest that the first birds to return to small fragments or young second growth are generally young birds, and they are probably not likely to breed. While it is encouraging that so many birds use second growth, more than 30 years of second growth development appear to be necessary for population establishment of most species in central Amazonia.

Cost effective environmental investment - A new framework

Strang, Melanie; Cesare Pacini, David J. Pannell, Anna M. Roberts, Geoff Park, Jennifer Alexander
Ecoedge, Australia

Environmental problems are much larger than the budgets allocated and programs are often not achieving cost-effective outcomes for public investment. A new asset-based tool that enables transparent, effective and informed decision making regarding investment in environmental projects has been developed and is now used extensively in Australia. Called INFFER (Investment Framework for Environmental Resources), this tool is a seven-step process that assists users to identify the most valued environmental assets within regions and determine which are the most cost-effective to protect through calculation of a Benefit:Cost Index (BCI). Different scenarios can also be tested to identify the most effective way of achieving stated project goal(s). In 2010, in the first international trial, INFFER was applied to increase conservation of endangered steppe birds within an 1180 hectare nature reserve near Siena, Italy, which is farmed by thirteen individual landholders. Levels of farmer participation were investigated by manipulating the amount and type of incentives received for converting from cropping to pasture in areas of endangered bird habitat. This in turn significantly affected the proportional achievement of the stated goal, and the BCI. The BCI was 0.8 for current EU incentive levels, indicating poor cost-effectiveness. The BCI increased to 1.7 for full payment to offset costs of lost production plus assistance to transition to new technology. INFFER allowed more robust determination of the minimum amount of funding required to secure the optimum level of farmer involvement for optimum area of habitat conserved.

Enhancing degraded woodlands in the Western US: Landowner case studies of innovation and cooperation

Stringer, Darin
Forest Restoration Partnership, USA

Private non-industrial landowners in the Pacific Northwest, U.S.A are increasingly engaging in cooperative relationships to restore degraded and declining forest habitats; an important trend because these are lands often contain high biodiversity values and are mostly unprotected. Effective and tested strategies to restore composition, structure and function in these plant communities are lacking. The following case studies will briefly describe cooperative habitat restoration in the state of Oregon on privately owned lands involving conservation organizations, academic institutions, and individual landowners: 1- Oregon White Oak (Quercus garryana) savanna restoration in the Willamette Valley 2- Quaking aspen (Populus tremuloides) woodland restoration in shrub-steppe habitats 3- Ponderosa pine (Pinus ponderosa) woodland restoration in the Eastern Cascade Mountains These case studies will focus on practical applications for treatment and monitoring of small scale restoration projects. A variety of innovative techniques were tested including use of bark beetle pheromones to create standing dead trees for cavity nesting wildlife, micro-understory restoration using prescribed fire, herbicides and native plant seeding, tree thinning to maintain/enhance the spatial diversity of tree distribution, and use of low impact forestry equipment to remove invasive trees. Preliminary results from these cooperative restoration projects will be presented. The discussion will culminate with key elements of a successful multiple-partner project on private lands, and a brief interaction with audience on applicability/transferability of these methods to other landscapes.

Using mosaic thinning to restore ponderosa pine stands

Stringer, Darin
Forest Restoration Partnership, USA

Throughout the dry ponderosa pine forest zone of the interior Western United States, millions of acres of forest have been replaced by young, structurally simplified stands. These structural and compositional changes have reduced habitat quality for focal wildlife (flamulated owl and pygmy nuthatch), altered disturbance regimes and reduced resilience, while impacting other human benefits. Active management to restore features of the reference era forest has been widely recommended. However, new approaches to achieve this range of conditions are needed. Mosaic
Thinning was designed as a silvicultural strategy to restore complex spatial tree patterns and uneven age structure in young ponderosa pine stands. This approach combines variable density thinning applied at clump and patch level spatial scales. The prescriptions are driven by the desire to accelerate tree diameter growth, control beetle mortality, increase clumpiness and new tree cohorts, while re-establishing reference tree and understory plant composition and dead wood levels. Mosaic thinning prescriptions are being applied on two project areas near Sisters, Oregon: 1) a 1,200 acre private tract owned by the Deschutes Land Trust, and 2) The 1,000 acre Glaze Stewardship Project. These projects will be used as case studies to highlight the development and application of this silvicultural approach. The presentation will cover the ecological and silvicultural basis for mosaic thinning, how to assess stands, set stand density and tree pattern targets, layout and mark trees. A simple monitoring methodology to gauge pre and post treatment spatial variability of tree distribution will be discussed.

**Testing the suitability of mineral accretion for cold-water coral reef habitat restoration**

*Strömberg, Susanna*

University of Gothenburg, Sweden

Deep-water coral reef habitats have declined globally from destructive fishing methods. Heavy bottom-trawling gear severely reduces habitat complexity, leaving fields of dead coral rubble with little or no capacity for recovery. In the northeast Skagerrak several reefs within the Koster sea archipelago have disappeared during the last two decades. The area is now protected through a recently inaugurated marine national park, which explicitly aims to restore and replant cold-water corals. There is a need to develop efficient methods for habitat restoration to compensate for loss of habitat complexity and speed up recovery of reef habitats to regain ecosystem services. Biorock technology with electrolytically induced mineral accretion provides flexibility in design and offers a semi-natural substrate in the form of aragonite, the same calcium carbonate mineral as coral skeleton. The applied electrical field over the electrodes could function as a microcurrent electrical therapy for transplanted corals, speeding recovery. Mineral accretion and its suitability as a method for habitat restoration of the local reef-building scleractinian *Lophelia pertusa* (Linnaeus, 1758) was tested in a laboratory experiment. Three levels of current densities were tested and resulted in increased budding at the lowest current density (0.06 A m-2). The results are congruent with previous studies and the increased budding could prove valuable in restoration programs since it will lead to a more rapid outgrowth of transplanted corals into a complex matrix of branches. Field experiments are planned to be launched in October 2011.

**Trait-filter models as tools to assess lepidopteran community re-assembly in tallgrass prairies**

*Summerville, Keith*

Drake University, USA

The re-assembly of native communities in restored landscapes is a relatively unexplored phenomenon. Ecologists lack the ability to generalize about how species traits, habitat size, habitat type, and temporal variation interact to affect species diversity. To investigate these relationships, I sampled moth communities from 10 prairie remnants and restorations over a 3-yr interval to test hypotheses regarding how life history variables and habitat characteristics determine the degree to which restored habitats develop a moth fauna similar to remnants. Moth assemblages in restored prairies that were > 7 years old were similar to those in remnant prairies. Community similarity, however, was driven by common moth species likely to occur in the surrounding agricultural habitat. Species persistence was significantly influenced by a series of trait combinations involving dispersal ability and niche breadth. Temporal variation independent of habitat type or patch size was the most significant determination of variation in species composition. These results suggest that lepidopteran persistence in restored landscapes is at least partially determined by species’ life history attributes. The correlation between sampling year and species richness suggests that weather effects and inter-annual differences in sampling bias may make it difficult for land managers to detect changes in species abundance following habitat management. Species may not necessarily possess life history traits that reduce extinction risk or enhance recolonization probabilities in the highly modified agricultural landscape of the Midwestern USA. Rather, certain traits may influence the ability of species to maintain populations in the greater agricultural landscape.

**Restoring rivers: On a bumpy road to success**

*Sundermann, Andrea; Stefan Stoll, Peter Haase*

Senckenberg, Germany
Previous studies evaluating the success of river restorations have rarely found any consistent effects on benthic invertebrate assemblages. Therefore, we ask for potential causes which impede benthic invertebrates from recolonizing restored river sections. The first aspect which has been evaluated is if the restoration success depends on the recolonization potential of the surroundings. For this, we analyzed data from 24 river restoration projects in Germany dating back 1 to 12 years and 1231 data sets from adjacent river reaches that lie within 0–5, 5–10, and 10–15 km rings centered on the restored sites. We show that restoration success depends on the presence of source populations of desired taxa in the surroundings of restored sites. Only where source populations of additional desired taxa existed within a 0–5 km ring around the restored sites, benthic invertebrate assemblages improved by the restoration. Beyond the 5 km rings, this recolonization effect was no longer detected. Secondly, we questioned whether structural degradation does - like often expected - really have such an overriding importance. Therefore, we asked whether water quality, habitat structure, or a combination of both can explain species assemblages best. Our results clearly indicate that habitat structure is not the primary factor controlling benthic invertebrate diversity. Instead, multiple stressors are the driving forces in water ways. Thus, future restoration projects should not solely focus on structural improvements of rivers, but encompass all stressors, water pollution and habitat structure as well as the recolonization potential of the surroundings.

**Hay mulch improves soil stability and stimulates establishment of native willows on eroded land**

Svavarsdóttir, Kristín; Ása L. Aradóttir, Anne Bau

Soil Conservation Service of Iceland

Unstable surface has proved to be a major challenge for plant establishment and growth on eroded land in Iceland. Restoration may, amongst other things, ameliorate conditions or choose an appropriate propagation method to overcome this threshold. The aim of the current study was to determine a suitable method for establishing two native willow species on an unstable, eroded surface. An experiment was established in 1999 at a sparsely vegetated site in South Iceland for testing different propagation methods, and the impact of fertilizer and hay mulch. The experiment was surveyed in 1999–2002, 2005 and 2010. Plants were scored for vigor, and their height and crown dimensions measured. Impact of frost heaving on plants was estimated in 2001. Survival depended on treatments. Containerized plants had higher survival rate than cuttings, and plants in hay mulch survived much better than those grown without hay mulch. In 2002, containerized plants were much larger than cuttings, but by 2010, the cuttings had reached the size of containerized plants. In 2010, size of both species averaged 0.5 m² when grown in hay mulch while just over 0.1 m² without it. Plants grown in hay mulch were less affected by frost heaving than those planted without it. Hay mulch appeared to stabilize the ground and create better conditions for native willows to survive and grow, indicating that site conditions were more important than the propagation methods used.

**Intraspecific variation matters for wetland plant response to hydrologic extremes: Implications for restoration**

Sweetman, Amanda

Utah State University, USA

Revegetation of wetlands in arid climates, such as those found in the Great Basin of the Western United States, is challenging due to water limitations. The use of locally collected seed is generally recommended for restoration projects; however, this can lead to the introduction of low levels of intraspecific diversity. Introducing higher levels of intraspecific diversity can be important because it represents the evolutionary potential of a species to react to new selective pressures such as hydrologic extremes due to climate change or the restoration process itself. Our objectives were to (1) gain a better understanding of the structure of intraspecific variation of *Schoenoplectus maritimus* across spatial scales in the region, and (2) investigate how that variation might influence ecosystem services (i.e. biomass production). Results from an observational study and greenhouse experiment revealed that even within a small geographic range this species was highly variable. In the observational experiment, plants exhibited widely divergent phenotypic traits (e.g., 26-fold differences in stem densities) and were found to occur in a wide variety of environmental conditions (water depth and salinities among sites varied 3- and 8-fold, respectively). Our genetic sampling revealed that clones were generally ≤1 m², and that genetic distance increased with geographic distance. In the greenhouse experiment there was no one seed source that did well or poorly in all categories measured in response to hydrologic extremes. These results suggest that including seeds from all sites sampled for this study could improve restoration success.
Connecting tropical forest restoration with biodiversity conservation in human-modified landscapes
Tabarelli, Marcelo
Universidade Federal de Pernambuco, Brazil

The future of tropical forest biodiversity and the invariably undercompensated environmental services provided by this ecosystem is largely dependent on the prospect of remaining forest habitats in human-modified landscapes—the predominant environment across many previously forested tropical lands. Recent research, however, has alerted to the extinction of several forest-dependent organisms in parallel with the proliferation of few disturbance-adapted species across these landscapes. Such progressive biodiversity erosion results in depauperate species assemblages and drives forest remnants towards early-successional systems. Although forest restoration initiatives usually intend the re-establishment of ecological services, e.g. carbon sequestration and flooding control, restored habitats are likely to increment the conservation services provided by modified landscapes. Briefly, restored forest patches should be used to alter landscape spatial configuration and thus guarantee higher levels of structural connectivity and buffering of edge-effects. Moreover, restoration actions and the resulting forest patches would be consciously used to increment genetic variability, the number and population size of target groups at landscape level, such as endemic and officially threatened species. Many other connections between forest restoration and biodiversity persistence are in fact possible if conservation targets (from species to community level) are intentionally incorporated into restoration approaches. Achieving biologically viable restored forests that enhance biodiversity persistence and the provision of ecological services at landscape/regional level represents a stimulating challenge for restoration science and an increasing demand on society.

Avoiding compensatory mitigation by maintaining, enhancing and creating habitat during industrial site demolition and remediation: A case study from San Jose, California
Tallis, Joshua; James Tull, Nick Kautzman
ARCADIS U.S.

Population growth and associated development have resulted in habitat loss for many species in the US. Many animals have adapted to altered landscapes by utilizing structures created for human benefit such as California tiger salamander (Ambystoma californiense) breeding in stock ponds or bats roosting in buildings. Given these expansions of niche space, demolition and remediation of historic facilities can also lead to habitat loss. During environmental clean-up at a former industrial facility in San Jose, California, ARCADIS biologists used an innovative approach to achieve remediation goals and minimize collateral disturbance by maintaining, enhancing and creating habitat. By working closely with natural resource agencies we significantly reduced the amount of habitat that would have been disturbed and required compensatory mitigation. This presentation outlines the approach taken by ARCADIS using a case study from wetland habitat created on a former building site. The complete removal and landscape stabilization of all structures at the San Jose project site would have had significant environmental disturbance. The approach used by ARCADIS resulted in significant habitat being maintained, enhanced and created.

Foundations of trust: Integration of indigenous communities into cloud forest conservation in Quiché
Department, Guatemala
Tanimoto, Philip; Luis Merino Martin, Juan Camilo Villegas Palacio
Conservation Imaging, Inc., USA

Too often, ecological restoration is conceived as a set of manipulative activities on the landscape, rather than a negotiation of interests between diverse parties over ecosystem goods and services. These negotiations are particularly important and challenging where historical social conflict has caused the mistrust of outsiders. We present a conceptual framework that facilitates collaboration between indigenous farmers and restoration ecologists, to improve forest management and to implement long-term planning processes. We apply this approach to conserve tropical cloud forests in rural Guatemala with the support of indigenous Mayan communities. A set of key steps is crucial to develop community-based conservation projects: 1. Learn to understand the existing governmental, NGO, and religious infrastructure. 2. Meet with village leaders with the goal of understanding community history, needs, and challenges. 3. Understand the 'domestic economy', i.e. how resources in the home are procured, and used and how that economy interfaces with the broader economy. 4. Educate the people about how restoration efforts can help them and their descendants. With these baseline items accomplished, the doors are open to an array of activities that further strengthen trust and collaboration, including: 1. Social surveys, biological inventories, and semi-structured community meetings. 2. Environmental and sustainability training workshops. 3. Establishment of long-term...
sustainability planning procedures which address indigenous goals. In rural Guatemala, and we suspect widely, forest and watershed restoration will not occur without the direct involvement of local indigenous communities, and the implied or explicit permanence of collaboration and cooperation.

**USVI coastal habitat restoration through watershed stabilization**

**Taylor, Marcia**  
Resource Conservation and Development Council, US Virgin Islands

Three U.S. Virgin Islands (USVI) watersheds (Coral Bay, East End Bay, and Fish Bay) are currently benefiting from a Watershed Stabilization project funded by American Recovery and Reinvestment Act funds. Sediment load reduction across all three watersheds should total 130 tons. Installation of 44 Best Management Practices (BMPs) will minimize terrestrial sediment generation and release into coastal habitats. The BMPs to be implemented include paving priority road segments, road drainage improvements, retaining walls, and re-vegetation of riparian areas. The project will result in road improvements to 2.1 km of unpaved road in the USVI. BMP effectiveness will be assessed through monitoring of the sediment source, watershed-scale sediment yields, as well as habitat condition in receiving bays. The monitoring program will establish baseline conditions (sediment yield and rates, coral reef ecosystem condition) and post-BMP sediment loads at the source and destination sites. Implementation of this watershed-scale project is used to demonstrate how conventional and alternative BMPs can be used to reduce the impact of erosion to area residents and government officials. Land-based sources of pollution are one of the major stressors to coral reef, seagrass, and mangrove ecosystems.

**Greencorps Chicago-Calumet (GC-C): Restoration in Chicago’s southeast side**

**Taylor, Zachary**  
WRD Environmental, USA

Greencorps Chicago-Calumet is a job-training program focused on ecological restoration in Chicago, Illinois. GC-C provides training in natural resource management for Chicago residents that have little to no experience with ecological restoration. Many of GC-C trainees have barriers to employment such as a criminal background or lack of education. The GC-C job training program is made possible by an America Recovery and Reinvestment grant provided to the Chicago Department of Environment (CDOE). The grant is administered by the United States Department of Agriculture. The Chicago Department of Environment has long recognized the importance of Chicago’s open spaces and natural areas. An example of this commitment is the Calumet Open Space Reserve, which protects nearly 4,000 acres of wetlands, woodlands, prairies, and open spaces on Chicago’s southeast side. The Calumet region, once known as a global industrial powerhouse, is now transitioning from “brownfields” into an ecological corridor with protected high-quality regional landscapes and improved habitat for endangered animals and plants. It was with these open spaces, rare plants, and animals in mind, that CDOE created the GC-C training program. Trainees receive classroom and on the job training in forestry management, prairie and wetland restoration, invasive species removal, and prescription burn application. GC-C trainees also receive an introduction to Calumet regional ecology and natural history. Program participants use this knowledge to implement on-the-ground restoration projects with partner organizations throughout the Calumet region.

**In the eye of the beholder: Learning to be multicultural in restoration**

**Temperton, Vicky M.**  
Forschungszentrum Jülich, Germany

I believe that one essential step in helping us to bridge the gap between science and practice is to learn to understand one another’s languages, and this involves investing time & energy and bringing openness for the stories the others tell. I will present how intriguing insights gleaned from discussions of the results of our SERI 2009 delegate questionnaire between us coauthors showed how our varied perspectives on restoration colored our perception of the interpretation of the results – but that in the end we are actually a lot closer in overall perspective than we think.

**Experiences with testing ecological theories in restoration settings and using ecological knowledge for restoration**

**Temperton, Vicky M.**  
Forschungszentrum Jülich, Germany
I will provide an overview of my experiences applying ecological theory to restoration settings as well as attempting to derive useful knowledge for practical restoration from ecological experiments and the testing of theories. Examples will be drawn from editing the book “Assembly Rules and Restoration Ecology- bridging the gap between science and practice” and what we aimed to contribute towards with this book including what tended to work and what did not work so well. More recent application and testing of ecological theory in grassland restoration settings and using insights from grassland experiments to inform restoration will be showcased briefly. Then an attempt will be made to link this work to more elaborate community approaches including considering networks of species within restoration.

**How to include ecosystem degradation and restoration in global and regional biodiversity outlooks?**

**ten Brink, Ben; Tom Kram, Mark van Oorschot, Stefan van der Esch, Rob Alkemade, Robert Ahrens, Michel Bakkenes, Jan Bakkes, Maurits van den Berg, Villy Christensen, Jan Janse, Michel Jeuken, Paul Lucas, Ton Manders, Hans van Meijl, Elke Stehfest, Andrzej Tabeau, Defleif van Vuuren, Harry Wilting**

PBL-Netherlands Environmental Assessment Agency

The 2010 target of the Convention on Biological Diversity to significantly reduce biodiversity loss, worldwide, has not been met. Conservation and protection will remain important measures to safeguard biodiversity. However, this will not be enough to counter the growing pressure on natural ecosystems – reducing species’ prospects for survival as well as the supply of essential goods and services. Reducing biodiversity loss globally requires a rethinking on the strategic orientation, from traditional conservation towards structural changes in production and consumption. An ambitious cross sector strategy was explored with the global GTAP-IMAGE-TIMER-GLOBIO model train. We explored a combination of measures, which include an expanded protected area network, more efficient agriculture and forestry, improved forest management, less meat-intensive diets, restoration of marine fish stocks, climate change mitigation and reducing post-harvest food loss. These measures also contribute to other objectives, such as improving food security, mitigating climate change and reducing eutrophication. This global strategy could halve the rate of biodiversity decline, by 2050, compared to the projected loss without new policies. In my presentation I would like to challenge the members of the Society for Ecological Restoration how we could better include large-scale restoration in planning for the future.

**Monitoring carbon stocks in reclamation areas of Iceland**

**Thorsson, Johann; Guðmundur Halldorsson, Anne Bau, Kristin Svavarsdottir, Asa L. Aradottir**

Soil Conservation Service of Iceland

The Soil Conservation Service of Iceland’s (SCS) primary objective is reclaiming degrading and eroded lands. In 2007, the SCS adopted a country wide systematic sampling approach, combined with GIS mapping, in order to monitor changes in carbon stocks in revegetation areas. This includes permanent sampling and measuring plots for vegetation and soil analysis and sampling that have been established at the intersections of a 1x1 km grid that fall within areas with revegetation activities. Currently around 800 plots in revegetation areas all over Iceland have been selected as potential sampling plots; of those 435 have been sampled during the last four years. Each plot will be re-measured every 5 years, starting in 2012. This program will provide extensive data on total revegetated land on a country scale; it will give more accurate estimate of carbon stock changes and will be a valuable tool for assessing vegetation changes and succession after revegetation. Current results indicate that revegetation areas sequester 2.75 t CO2 yr-1, but the rate varies with time and method of revegetation. A trend can be seen for vegetation cover and SOC, both depending on plant communities and amount of cover. Established plant communities, such as birch woodlands, tend to have high SOC, whereas degraded woodlands and heathlands have lower SOC. The same trend is observed in heathlands where sites with high vegetation cover (measured as NDVI) tend to have higher SOC than sites with proportionally lower vegetation cover.

**Harvesting seeds from species-rich meadows for grassland restoration: The SALVERE project**

**Tischew, Sabine; Anita Kirmes, Michele Scotton**

Anhalt University of Applied Sciences, Germany

In Central Europe, species-rich grasslands are highly endangered by land use intensification and abandonment. The protection of genuine, natural grasslands containing regional sub-species and ecotypes in region-specific compositions is a top priority in nature conservation. In addition to the high ecological and aesthetic values of these grasslands their economical value as donor sites for valuable seed mixtures should be considered. Within the
SALVERE project, seed mixtures were harvested in three different species-rich donor grassland communities via mowing, threshing, and brushing. The harvested material was applied on suitable receptor sites comprising former arable land, ploughed species-poor grasslands, and raw soils. Altogether, 17 large-scale trials were realized in six countries (Austria, Czech Republic, Germany, Italy, Poland, Slovakia) during summer 2009. First results show that transfer rates of donor site species differ significantly dependent on different receptor sites as well as restoration methods. For example, transfer rate of green hay is more successful on raw soils (62.4 ±17) than on former arable land (39.1 ±3.9) or disturbed grasslands (31.0 ±3.2). After one year, the share of target species on total coverage strongly depends on the type of harvested donor site as well as on the type of receptor site. Receptor sites on raw soil showed the highest proportion of target species. Based on the results of the project as well as literature findings, recommendations for the selection of best practice methods in grassland restoration under different starting conditions will be presented.

Nature and culture in Mexico: Ecological or bio-cultural restoration?
Toledo, Victor M.
Centro de Investigaciones en Ecosistemas, UNAM, Mexico

As a historical consequence of both natural and cultural processes, Mexico is a megadiverse and megacultural country containing 10% of the biological diversity found on the planet, 68 language groupings, and 364 language variants. All that expresses the heritage of a singular civilizational pole of humanity: the Mesoamerican Civilization. In addition, Mesoamerican peoples domesticated 15% of the plant species that make up the world’s food system, and also manipulated not only plant populations but landscapes. This savoir-faire about nature, largely perfected during almost 9,000 years, constitutes without doubt the bulk of the biocultural patrimony that exists in Mexico. Today, the Mesoamerican indigenous population includes about 12 to 16 million people distributed across 26 regions occupying the majority of habitats in Mexico. The peasant sector that still uses indigenous languages controls an area estimated in at least 28 million hectares This paper is making a brief review of the main examples of ecological restoration by traditional peoples in Mexico including terraces, hydraulic agricultural systems, agroforestry coffee systems and homegardens. The paper finishes calling the attention about the necessity to create a new concept of bio-cultural restoration, where degraded areas be regenerated with the co-participation of local people, and the complementary concourse of both scientific knowledge and traditional wisdom.

How sustainable are sustainable mire and peatland strategies?
Tolvanen, Anne
University of Oulu, Finland

Finland has about 10 million hectares of mires and peatlands, which is a third of the land area. 52% of the area of mires has been drained for forestry use, 13% is protected, and 60,000 hectares/yr are used for peat production. Due to the multiple needs and values of peatlands, preparation of Finnish National Strategy for Mires and Peatlands was launched by the Ministry of Agriculture and Forestry in early 2009. The aim was to create common understanding of the sustainable and diverse use of mires and peatlands. The proposal was submitted in February 2011. Simultaneously, discrepancy notices came into publicity from inside the group, from external experts and from an EU parliament member, who made a parliament question claiming that the proposed strategy supports burning of peat rather than environmental protection, nature conservation or restoration. At the same time when the National Strategy was completing, planning of local mire and peatland programs with similar aims on sustainability was launched. In Northern Ostrobothnia, the peatland-richest region in Finland, local stakeholders have been involved in the local program through interviews and questionnaires, which concern opinions towards peatland use and values of peatlands. Participation of people is expected to increase the social acceptability of the local program. However, conflicting opinions revealed by the questionnaires regarding the use of peatlands indicate that also the local program will face strong arguments regardless the suggestions. Further results from questionnaires will be shown in the conference.

Sacred site conservation at Sand Mountain, Nevada, USA
Tonenna, Dean
US Bureau of Land Management

Sand Mountain, Nevada is one of the most sacred sites for the Native American Toetukadu people. The endemic biodiversity found within this dune ecosystem is exceptionally rare and is negatively impacted by motorized vehicles. The Bureau of Land Management (BLM), a U.S. federal agency, manages Sand Mountain as a recreational
area and is also responsible for managing and protecting natural and cultural resources within the area. The increased popularity of Sand Mountain has led to fragmentation of the habitat with numerous unauthorized trails proliferating throughout the dune ecosystem. The BLM conducted a spatiotemporal study utilizing remotely sensed imagery to determine the extent and rate of habitat fragmentation and began a long term monitoring effort to better understand the impacts of motorized vehicles within the dune area. The agency met with tribal, recreational and environmental representatives to craft a strategy for restoration at Sand Mountain. Part of that strategy involved restoration of disturbed areas utilizing native plants having important cultural values to the Toetukadu.

Las reservas marinas completamente protegidas como herramienta de restauración en el Noroeste de México

Torre, Jorge
Comunidad y Biodiversidad, A.C., México

Las reservas marinas completamente protegidas (zonas núcleo, no pesca, refugio) están consideradas a nivel mundial como una poderosa herramienta para la restauración de los ecosistemas y las pesquerías. En el Noroeste de México (Golfo de California y Pacífico de la Península de Baja California) se han establecido 18 reservas marinas, ya sea como zonas núcleo en las 14 áreas marinas protegidas (áreas de protección de flora y fauna, parques nacionales, refugios o reservas de la biosfera) existentes en esta región, las cuales abarcan un total de 303,654 ha, o las cuatro a nivel comunitario, con un total de 2,859 ha. En cada una de estas reservas el grado de restauración del ecosistema varía, desde la espectacular recuperación de la fauna asociado a los arrecifes de coral en el Parque Nacional Cabo Pulmo en 16 años desde que se estableció, hasta la larga recuperación en la Reserva de la Biosfera Isla San Pedro Mártir establecida (2002), o la nula recuperación de la vaquita marina en su refugio. Para lograr la restauración de los ecosistemas a través de reservas marinas es necesario considerar: 1) tipo de ecosistema, 2) grado de impacto, 3) cumplimiento de la inspección y vigilancia, 4) voluntad política y 5) participación de los usuarios. Este último elemento debe involucrar a los usuarios en todas las etapas del diseño, establecimiento y evaluación de las reservas.

Regeneración natural asociada al manejo del fuego en la Reserva de La Biosfera Selva El Ocote, Chiapas, México

Torres Álvarez, Martha Marisol; Roberto Reynoso-Santos
Comisión Nacional de Áreas Naturales Protegidas, México

Los incendios forestales has sido una de las principales causas de destrucción de la Reserva de La Biosfera El Ocote, considerada como un área de alta incidencia de incendios forestales, naturales y provocados. De 1998 a 2007 ocurrieron 64 incendios que afectaron el 31% (32,093.90 ha) del territorio de la Reserva. La superficie afectada corresponde a tres de los seis tipos de uso de suelo presentes. El proyecto consistió en evaluar la tasa de repoblación de especies después de un incendio forestal en tres ecosistemas: Selva Alta Perennifolia (SA), Selva Mediana Subperenifolia (SMSP) y Selva Baja Caducifolia (SBC); como un parámetro de decisión para facilitar la restauración de las áreas afectadas. Como base se tomaron los incendios ocurridos en 1998 y 2003. Por ecosistemas y manejo se muestrearon tres parcelas circulares concéntricas de 1000 m2, obteniendo la estructura y composición de cada uno de ellas. Todas mantenían conectividad con los sistemas del paisaje. En las SA perturbadas se presentaron cinco de las 12 especies dominantes de SA, Swietenia macrophylla se ausenta en su totalidad y domina Heliocarpus reticulatus. En las SMSP la presencia de 14 especies se asocia a la perturbación por fuego, 10 especies como, Astronium graveolens y Oreopanax geminatus no se ven favorecidas. Byrsonimia crassifolia y Acacia milleriana dominan en SBC después del disturbio, ausentándose Protium copal, especie dominante en la SBC conservadas. La facilitación de la restauración es viable en aquellas zonas extensas donde la dominancia de una especie modifica sustancialmente la matriz del paisaje.

Using GIS to define restoration priority areas in a Southern Ontario landscape

Towle, Ken
Ganaraska Region Conservation Authority, Canada

In the fragmented forest landscape of southern Ontario it is not enough merely to protect remaining natural areas; an approach is needed that defines target areas to restore and improve landscape connectivity and ecological functions. The Ganaraska Region Conservation Authority (GRCA) used ArcMap GIS software to map and classify existing landscape features based on air photo interpretation. A GIS vector analysis was applied to give each habitat patch a score based on size, shape, and surrounding landscape matrix. A raster analysis was then used to evaluate the entire landscape according to criteria related to conservation biology principles and the needs of sensitive species. The
landscape was divided into 10m x 10m pixels and each received a score based on the degree to which they met the criteria. A histogram representing the total landscape pixel values was used to select thresholds for defining target natural heritage system scenarios. The vector analysis of patch characteristics was re-applied to show improvements in patch characteristics that could be achieved through restoration work. The results are being used to set priorities for landowner contact for forest and tallgrass prairie restoration. The target systems are helping municipalities to implement provincial policy for the protection of natural heritage features and ecological functions. The approach also provides an opportunity to educate municipal planners, politicians, and the public about biodiversity conservation and restoration issues.

Los hongos micorrízicos benefician el crecimiento de plantas, pero ¿qué sucede con la germinación?

Trejo Casanova, Nayeli; Fernando Arellano-Martín, María Dzul-Celis, Fernando Colli-Balam, Marieli Verde-Tah, Horacio Salomón Ballina-Gómez
Instituto Tecnológico de Conkal, México

Efectos positivos de hongos micorrízicos sobre la adecuación y crecimiento de plantas son conocidos. No obstante, se tiende escasa información de su influencia en la germinación de semillas, a pesar de que su uso la mejoraría, lo que es de suma importancia en programas de restauración de selvas. Presentamos un estudio sobre el efecto de los hongos micorrízicos y la disponibilidad de luz sobre la germinación de especies con potencial ecológico y económico como la producción de biodiesel. Usamos tres especies: Mirabilis jalapa, Moringa oleifera y Caesalpinia pulcherrima; Dos sustratos: tierra de la selva + nutrimentos (control) y Glomus intrarradices (micorriza); Luz: 70, 50, 30 y 10%. Calculamos la germinación (%) y su índice de velocidad (IVG). Únicamente fue significativa la interacción luz x sustrato en IVG en M. jalapa, ya que incrementó con la micorriza conforme disminuyó la luz. En M. oleifera aumentó sólo con menores porcentajes de luz, caso contrario en C. pulcherrima. Los porcentajes de germinación en M. jalapa y M. oleifera incrementaron con la reducción de luz. Sólo en M. jalapa aumentó con la micorriza. A nuestro conocimiento presentamos uno de los primeros reportes experimentales que la aplicación de micorriza no únicamente incrementaría la germinación, sino que también aceleraría su proceso, independientemente de la cantidad de luz disponible, aunque son necesarios más estudios para fortalecer esta idea.

Restoration planning in Galapagos – Knowing what was there before humans interfered

Trueman, Mandy; Richard Hobbs, Kimberly van Neil
University of Western Australia

Knowledge of the historical range of variation is an important tool for making decisions about management objectives for ecological restoration. Variables include composition, structure, spatial and temporal distribution, and biotic and abiotic interactions. The humid highland area on the inhabited island of Santa Cruz in Galapagos has been highly altered by land clearing for agriculture and invasive species in the last 50 years and is now replaced by a mosaic of agricultural land, hybrid and novel ecosystems. We used historic vegetation surveys from the 20th Century and air photos from 1959 to 1963 to visualize the historic highland vegetation of Santa Cruz. Original vegetation on Santa Cruz Island was observed to be spatially and floristically dynamic on a decadal time-scale. By 1980 the land clearing was complete and a process of biological invasions commenced. Today there remains only very little historical vegetation in the highlands of Santa Cruz. Furthermore, none of the once widespread brown zone exists (a zone dominated by the long lived tree Zanthoxylum fagara covered with characteristic hanging moss and lichens). This historic recreation provides the opportunity to help managers direct the management of this ecological system to maximize native biodiversity and function.

Restauración de áreas de páramo afectada por incendios en el Parque Nacional Natural los Nevados, Colombia

Trujillo Ortiz, Ledy Nohemy; William Vargas, Jorge Lotero, Erika Nadashowsky, Germán Páez, Oscar Castellanos, Jairo Largo, Benicia Matteiñe, Jorge Iván Bedoya
Universidad Nacional de Colombia

En 2,006 se presenta un incendio en áreas de protección del Parque Nacional Natural Los Nevados, devastando 2400 hectáreas de páramo, iniciándose el proceso de restauración ecológica del área afectada, implementando 64 hectáreas de restauración activa y 2350 ha de restauración pasiva. Se propagaron especies nativas, implementadas en el área afectada dentro de módulos de restauración, enfocados a la formación de núcleos de vegetación que promueven la colonización, establecimiento y persistencia de especies claves en el proceso de recuperación. Así mismo se generaron corredores conectores entre estos núcleos y los encontrados relictualmente, para estimular a futuro la
conectividad de la vegetación y movilidad de la fauna en el paisaje. Actividades de monitoreo se han realizado luego de tres años de la implementación y han establecido las estrategias con mayor éxito y una sobrevivencia de máis del 60% de los individuos sembrados. Este proceso involucró acciones participativas con comunidades aledañas y Control y Vigilancia, vitales para el éxito y proyección de esfuerzos implementados. Así mismo se vincula a espacios de socialización y concertación en la toma de decisiones a nivel regional, para fortalecer la planificación y manejo de áreas de protección y sus alrededores. Se contó con el apoyo de instituciones como Embajada de Holanda, GEF, PNN Los Nevados, Aguas y Aguas de Pereira, Corpocaldas, CARDER y FNR.

La restauración ecológica como herramienta en la recuperación del bosque alto andino en áreas protegidas
Trujillo Ortíz, Ledy Nohemy; Orlando Vargas Ríos, Ruth Marina Díaz, Adriana Díaz Espinosa, Patricia Velasco, Olga León, Mónica Acosta, Patricia Torrijos, Alba Montenegro, Ángela Zabaleta, Alba Luz González, Jairo Solorza, Angélica López
Universidad Nacional de Colombia
La zona andina en Colombia presenta una alta deforestación de los bosques en el proceso de colonización y expansión de la franja agrícola, esto ha generado una gran alteración del ecosistema reduciendo su capacidad en la prestación servicios ambientales. Las áreas protegidas de zonas alto andinas presentan barreras a la regeneración natural del bosque, debido a los efectos de la fragmentación de la cobertura vegetal, alteración en las condiciones de suelo y microambientales en áreas de potreros y expansión de especies exóticas altamente competitivas. En la Reserva Forestal Municipal de Cogua, ubicada en la zona andina, entre los 2970 y 3650 m de altitud, se establecieron estrategias de diagnóstico e implantación de Restauración Ecológica, en áreas de borde de bosque, potreros abandonados y matorrales de la especie invasora Ulex europeus. Las estrategias se enfocaron en la ampliación y conexión de los parches de vegetación relictual, en acelerar y redirigir la sucesión hacia bosque, así como en generar estrategias de control y manejo de las especies oportunistas e invasoras. Se obtuvo información base acerca de los mecanismos de regeneración en el área de estudio, estrategias y especies potenciales para activar y direccionar la sucesión vegetal, formación de núcleos de vegetación que estimulen la implantación y establecimiento de propágulos de especies de bosque y parches de vegetación facilitadores en el desarrollo de arbustos nativos.

Development of occupational competency outcomes for environmental professionals in Canada - ECO Canada's academic accreditation program
Trump, Grant
ECO Canada
ECO Canada is a not-for-profit organization that was first established in 1992 under the federal government’s Sector Council initiative. Over the past 18 years, ECO Canada has grown into its own as an organization focused on supporting Canada’s environment industry by communicating with industry stakeholders, conducting research and creating the necessary resources required to address human resource needs in order to ensure the success of this dynamic sector. Over the past few years ECO Canada has been working closely with the Canadian University Environmental Science Network (CUESN) and the Canadian College Environmental Network (CCEN) to develop an environmental-specific program accreditation system for Canadian Colleges and Universities. This resulted in the formation of the Canadian Environmental Accreditation Commission (CEAC) which was called upon in June of 2010 to review their first round of applicants. Institutions that became accredited are recognized for offering environmental programs that are in line with industry needs. Specifically, their programs have been benchmarked against the industry created and validated National Occupational Standards (NOS) for environmental employment - the same standards that are used as the foundation of Environmental Professional certification; administered by ECO Canada and awarded by the Canadian Environmental Certification Approvals Board (CECAB). The process ECO Canada utilized in the creation of the National Occupational Standards (NOS) document will be presented. This process was integral in the completion of this crucial document that now forms one of the critical elements in both academic accreditation and professional certification of individuals.

Using diverse knowledge systems to achieve consensus for water quality management and restoration in the tropics
Tsatsaros, Julie; Iris C. Bohnet, Jon Brodie, Peter Valentine
James Cook University, Australia
Successful coral restoration programs are now being implemented on the Veracruz reefs. A mixture in the water column, and it has been shown to negatively affect corals both in the field and in the lab. Successful coral restoration programs are now being implemented on the Veracruz reefs.

Impacts of dam and hydroelectric power plant construction on environmental and social justice issues on the Tigris River watershed
Tuba Kılıç, Dicle
Doga Dernegi, Turkey

The Ilısu dam and other hydro-electric power plant construction projects on the Tigris River will result in irreversible environmental and social impacts. Turkey is one of the major dam building countries in the world, intending to build over 1,700 dams and hydro-electric power plants (HEPP) in addition to over 2,000 existing ones. Despite the extraordinary size of this plan, leaving hardly any river in the country unaffected, no environmental or social impact assessments at the basin or country level have been conducted. Impacts on the water resources, livelihoods of possibly up to 2 million people, biodiversity and ecosystem functions have not been evaluated. This talk is specifically about environmental and socio-economic impacts resulting from conversion and degradation of critical natural habitats on the Tigris River upriver from the international frontier with Syria and Iraq. This river section is relatively unaltered, with a mosaic of aquatic and riverine habitats and unaltered hydrodynamics. As a result of over 20 dams constructed on the Fırat (Euphrates) River in southeastern Anatolia, the Dicle River has become an important refuge for regional biodiversity. Dam operation involves completely stopping flows and dewatering the river channel for 2-5 hours a day, followed by a 3 m surge in river flow. These flow conditions have a devastating impact on aquatic and riparian biodiversity, as well as creating human rights violations. Over 30,000 environmental refugees face a future in extreme poverty, the loss of their livelihoods and history, and the disruption of their village and family structures.

Impact of oil spills on Gulf of Mexico coral reefs
Tunnell Jr., John W.
Texas A&M University, USA

Shallow-water coral reefs are distributed in five different regions of the Gulf of Mexico (clockwise): Florida Keys, northwest coast of Cuba, Campeche Bank, Veracruz shelf, and northwestern Gulf banks. Most of these are in oil tanker traffic lanes (Florida, Cuba, Veracruz, and northwestern Gulf) and some are adjacent to a very busy port (Veracruz). Oil and gas exploration is common in the northwestern Gulf (near Flower Garden Banks) and in the southern part of the Campeche Bank (Cayos Arcos), and exploratory drilling is about to begin in Cuba. Deep corals are fairly common in continental slope regions of the Gulf, and natural gas and oil seepages are not uncommon in some of these areas. Although natural seepage is common in the Gulf and minor to moderate oil spills are fairly common, only one major spill impacted shallow water coral reefs (Ixtoc I, Veracruz), and it appears that the recent BP Deepwater Horizon Macondo MC 252 blowout and spill may have impacted deep corals in the Mississippi Canyon of the northern Gulf. Floating oil is generally not detrimental to coral reefs if it is only temporarily passing over (1-5 days); however, dispersants should not be used around coral reefs, as they tend to put the oil-dispersant mixture in the water column, and it has been shown to negatively affect corals both in the field and in the lab. Successful coral restoration programs are now being implemented on the Veracruz reefs.
Influence of soil cap depth and vegetation on phosphogypsum stack reclamation in Alberta, Canada

Turner, E. Lenore; David Chanasyk, M. Anne Naeth
University of Alberta, Canada

Phosphogypsum (CaSO$_4$·H$_2$O) is an industrial byproduct created during phosphorus fertilizer production. At Agrium's Fort Saskatchewan plant, fertilizer production has ceased and phosphogypsum was pumped into settling ponds, dewatered and piled into solid stacks covering 35 ha. Phosphogypsum stacks can pose environmental hazards including residual acidity, small quantities of radium and uranium and elevated trace elements that can become mobile in water. This study quantifies environmental risks and will help to develop reclamation strategies for phosphogypsum stacks to support sustainable soil and vegetation systems. Experimental plots with soil cap depths (0, 8, 15, 30, 46, 91 cm) and vegetation treatments (four grass monocultures, a grass mix with *Trifolium hybridum*), established in 2006, are being studied. In 1 m cores from *Agropyron trachycaulum* plots, significant root mass accumulations occurred at the soil - phosphogypsum interface with 8, 15, 30 and 46 cm caps in 50% of the cores. Mean peak water content occurred at the interface with all cap depths. Maximum rooting depth increased with increasing cap depth. Above ground biomass increased with increasing cap depth to 30 cm where it plateaued. Substrate and above ground vegetation were analyzed via neutron activation for concentrations of 33 elements. Some substrate contained elevated fluorine, cobalt, cerium, europium, lanthanum, nickel, samarium, and ytterbium and some tissue contained elevated nickel and cobalt. Substrate and vegetation tissue from cap depths ≥30 cm contained lower select trace element concentrations including nickel, cobalt and fluorine.

Seed collections helping local communities to conserve and cultivate useful native plants

Ulian, Tiziana; M. Sacandè, P. Smith
Royal Botanic Gardens, Kew

Kew’s Millennium Seed Bank (MSB) Partnership has been pioneering the conservation of wild plants useful for human wellbeing by building the capacity of local communities to successfully preserve and cultivate these important species. Since 2007, high quality seeds and research information have been collected on 630 useful native plant species selected by communities in Botswana, Kenya, Mali, Mexico and South Africa. The communities range from schools, farmer’s groups and organisations, to traditional healers and organic crop producers. The seed collections were stored in seed banks in-country, as primary sources, and securely duplicated at the MSB in the UK. Information developed in the seed bank (e.g. germination protocols) was used to train farmers and propagate 20% of these collections that were then grown into seedlings and planted in local communities’ gardens. The research that was carried out on 168 of the species has been used to support their in situ conservation and cultivation. It is planned to pursue information dissemination on the species to local communities and relevant stakeholders through different channels such as published papers, posters, audio and video materials. The plant material and the information generated have been supporting species reintroduction and reforestation programmes and the enrichment of local forests. The success of the project has led to the development of an income generation component for the communities so that they benefit from biodiversity conservation, either through the direct sustainable use of the goods or indirectly through wider environmental and cultural services.

Restoration of European buckthorn (*Rhamnus cathartica*) invaded areas using soil carbon amendments

Umek, Lauren; Liam Heneghan
DePaul University/Northwestern University, USA

European buckthorn (*Rhamnus cathartica*) invades woodlands and forests in the Northeast and upper Midwest of the US. Ecosystems inundated with buckthorn are associated with elevated soil N and altered ecosystem processes that persist following buckthorn removal. We hypothesize that the legacy effects of buckthorn invasion contribute to its re-invasion and hinder native plant re-establishment after buckthorn removal and that successful restoration will be promoted by employing management techniques that reduce soil N concentrations after buckthorn removal. Soil carbon amendments, may reduce soil available N and facilitate restoration of buckthorn invaded areas. We tested the effects of several restoration methods on soil nutrient availability and buckthorn reinvasion in a randomized block design in a heavily invaded old-field site in Mettawa, Illinois. Restoration techniques included cutting and removal of *R. cathartica* followed by native or cover crop seeding; cutting and removal of *R. cathartica* followed by tilling mulched *R. cathartica* wood or commercially available wood followed by native or cover crop seeding; and cutting
and removal of *R. cathartica* followed by planting two rotations of corn. Our results indicate that reinvasion by *R. cathartica* is initially reduced when woody mulch (using mulch composed of *R. cathartica* wood, or a commercially available mulch) was incorporated into the soil compared to no soil amendments, but these differences diminished over time. Soil manipulations addition did not significantly reduce available N as expected, but plant nutrient supply rates were altered. This work is discussed in the context incorporating soil ecological knowledge into restoration practice.

**Use of occupational competency outcomes in the development of relevant curriculum: A case for the development of a “Body of Knowledge” for ecological restoration**

Unwin, Alan J.
Niagara College, Canada

Developing relevant curriculum for various academic courses associated with ecological restoration can be extremely challenging. From a curriculum design perspective – the use of documentation from related professional organizations can be useful in providing direction in identifying the various elements that courses and academic programs should touch upon. NiagaraCollege’s Environmental Management and Assessment (EMA) program recently completed a curriculum mapping exercise to determine the current status of the course curriculum in terms of its occupational relevancy. Learning outcomes for each course were compared against Competency Outcomes written for environmental professionals by the Environmental Careers Organization (ECO) in Canada. This exercise allowed NiagaraCollege to determine whether specific learning outcomes identified by ECO Canada were not being addressed within the program and at what level existing ones should be delivered at using Blooms taxonomy as a guide. Curriculum could then be updated to ensure that program outcomes were consistent with the Competency Outcomes ensuring that the learner was receiving current and relevant instruction in the area of Environmental Management. This process also provided one basic requirement used by ECO Canada in the accreditation of academic programs. NiagaraCollege’s EMA program received its formal academic accreditation in June of 2010 from ECO Canada. The Ecosystem Restoration post graduate program at NiagaraCollege is now attempting to undertake a similar exercise in reviewing its curriculum. This has been impeded by a lack of a relevant Occupational Competency document, or “Body of Knowledge”, to act as a guide specific to the ecological restoration profession.

**Integrating traditional knowledge to ecological restoration: An effective way to connect nature and culture**

Uprety, Yadav; Hugo Asselin, Yves Bergeron, Jean-François Boucher, Frédérick Doyon
Université du Québec en Abitibi-Témiscamingue, Canada

Traditional knowledge has become a topic of considerable interest within the research and development environment. The potential contribution of traditional knowledge to conservation and management is increasingly recognized and implementation endeavors are underway in several countries. The current scale of ecosystem degradation and damage underscores the need for restoration interventions. It is increasingly recognized that successful ecological restoration depends on effective coordination of science and traditional ecological knowledge. We reviewed the literature to evaluate the actual and potential contribution of traditional knowledge to ecological restoration. Despite a growing number of articles published on traditional knowledge only a few address the contribution to ecological restoration per se. Examples of ecological restoration practices are explored that have included traditional knowledge or practices that are compatible with ecological restoration. The main contributions of traditional knowledge to ecological restoration are in construction of reference ecosystems, particularly when the historical information is not available; selection of species for restoration plantation; selection of appropriate sites for restoration; knowledge about historical land management practices; management of invasive species; and post-restoration monitoring. These examples strongly advocate for the complementary benefits of using both traditional knowledge and science in ecological restoration projects. Moreover, incorporation of traditional knowledge can contribute to build a strong partnership for the successful implementation of restoration projects and to increase social acceptability, economical feasibility and ecological viability.

**¿Dónde restaurar primero?: Análisis de decisión multicriterio para identificar áreas prioritarias de restauración**

Uribe Villavicencio, David; Davide Geneletti, Francesco Orsi, Rafael del Castillo, Raúl Rivera
Ciidir Unidad Oaxaca (IPN), México
Combined use of the Biorock method with mat transplanting methods increased the seagrasses, and the durability of the mineral deposits produced by seawater electrolysis. Combined use of the Biorock method with mat transplanting methods increased *P. oceanica* attachment and stability for the necessary (long) time needed for recolonization of the meadows. These results suggest the possibility for large-scale use of this technology for seagrass restoration in the Mediterranean and elsewhere.

**Solubilización de carbón de bajo rango por microorganismos ligninolíticos: Una herramienta para aumentar el contenido de sustancias húmicas y sus efectos benéficos en suelos degradados**

Valero Valero, Nelson Osvaldo; Liliana Cecilia Gómez, Luz Nidia Rodríguez, Lady Aparicio, Jocelyn Beleño, Manuel Pantoja, Luz Marina Melgar

Universidad Nacional de Colombia
La biotransformación del carbón se basa en su semejanza estructural con la lignina, debido a su origen a partir de restos vegetales; por esta razón los microorganismos ligninolíticos también actúan sobre el carbón. El carbón de bajo rango (CBR) presenta alto contenido de sustancias húmicas (SH), las cuales son liberadas al medio por microorganismos que solubilizan carbón mediante enzimas ligninolíticas extracelulares, esterasas, agentes quelantes, surfactantes y sustancias alcalinas. Los mecanismos de transformación del carbón presentan una regulación compleja influenciada por condiciones propias del suelo, esto ocasiona dificultades para estandarizar y escalar procesos biotecnológicos económicamente factibles. Sin embargo, la biotransformación de CBR por microorganismos ligninolíticos directamente en el suelo es una alternativa viable para aprovechar estos materiales, liberando lentamente SH que posteriormente desencadenan efectos positivos sobre las propiedades de suelos degradados. Un escenario propicio para probar estas estrategias es la rehabilitación de suelos post minería, puesto que en minas de carbón a cielo abierto se generan grandes cantidades de CBR como subproducto de la extracción del carbón de alto rango, este material puede ser susceptible de aprovechamiento para incrementar la materia orgánica del suelo reconstituido. En esta investigación se obtuvieron microorganismos nativos que solubilizan eficientemente un CBR generado en la mina “El Cerrejón” (La Guajira – Colombia), la aplicación del CBR en suelos pobres en materia orgánica, en conjunto con microorganismos solubilizadores de carbón incrementó la respiración y actividad enzimática del suelo, redujo la densidad aparente y la compactación, favoreció la formación de agregados y estimuló el desarrollo de raíces y el crecimiento vegetal.

Effectively managing coral reef related fisheries in the Philippines at the community level

van Bochove, Jan-Willem; Pete Raines
Coral Cay Conservation, UK

Community-led no-take areas (NTAs) have become a popular tool for fisheries management in the developing world. Although it is clear that large-scale MPAs have a greater chance of meeting fisheries and conservation goals, these ideals are unrealistic in the Philippines where local authority of coastal waters by local communities has created significant hurdles, making holistic approaches towards coastal zone management challenging. The local governance system installed under the Fisheries Code of 1998 can therefore be seen both as a blessing and a curse to fisheries management in the Philippines. It empowers local communities to manage their own coastal waters but at the same time, it makes the installment of larger, integrated coastal management zones an immense challenge as it requires the cooperation of several independent barangays who will inevitably pursue their own interests. This talk proposes a means to develop networks of closely associated, NTAs in order to meet both local governance requirements and conservation goals. Under the guidance of the provincial government, barangays are assisted in setting aside a fraction of their coastline as a NTA. The combined effect means a greater proportion of reef habitats are protected and communities share the responsibility for their management. In Southern Leyte, Coral Cay Conservation has been working closely with the Provincial Government to develop such a network. This project was initiated in 2005 and has incorporated 7 NTAs into a network of 12. The project provides a good case study for locally led micro management of coral reefs.

Cultivating the ‘PRESENCE’ Learning Network to restore living landscapes

van den Broeck, Dieter; Odirihwe Selomane, Marijn Zwinkels, Bart van Eck, Matthew Zylstra
Living Lands, PRESENCE Learning Village, South Africa

Lessons learned: facilitating and enabling PRESENCE network to guide a transdisciplinary approach of integrated catchment restoration. “Learning in organisation/network means the continuous testing of experience, and the transformation of that experience into knowledge – accessible to the whole network, and relevant to its core purpose” (Senge et al., 1994). PRESENCE is a collaborative learning network (South Africa) that stands for ‘Participatory Restoration of Ecosystem Services and Natural Capital’. It aims at guiding ecosystem restoration of ‘living landscapes’. During the first PRESENCE workshop, a Transdisciplinary Assessment and Implementation Framework (TAIF) was developed and is refined over the last three years. The TAIF provides a ‘conceptual space’ for stakeholders, practitioners and scientist to determine what research, actions and contributions are required to effect restoration and how the involvement and participation of stakeholders must be embedded. The realisation over the last three years is that restoring of living landscapes is embedded in a complex and fluid natural, social and economic environment. There is a need for an environment that creates a space for continuous learning (scientific and social), making adaptive management possible. This presentation contributes to the discussion about the need and the important building blocks for a learning network and social learning. By sharing our experience, drawn for the pilot project within the Baviaanskloof Mega Reserve and assessing its current performance in relation to comparable structural dimensions, characteristics and criteria of such networks will feed this discussion.
Social technology/approach for creating collective awareness, understanding, intelligence and action on landscape for the creating and restoring of living landscapes

Van den Broeck, Dieter; Vanessa Sheehan
Living Lands, PRESENCE Learning Village, South Africa

We are living in a rapidly changing world. With dynamic and complex challenges which cannot be solved with the traditional approaches and leadership. The sustainability paradigm has placed much emphasis on our ecological-economic interactions; however implicit is the need for societal development. The multi-stakeholder nature of environmental issues results in the challenges being organisational and social, rather than technical. Therefore in the bigger scheme for initiating change, improving and deepening the way individuals and organisations interact within the system should be the foundation upon which restoration strategies are built. To be able to achieve this we need to create a collective awareness and understanding within the system. The way we "see" the world, determines what we "do" to it. Individuals make different evaluations of situations, which lead to different actions and perspectives. Managing networks can improve the capacity of a group to develop a culture of self-assessment for evaluating the results and for developing new knowledge and broadening the perspectives. This presentation brings forward a learning journey to create this collective understanding, awareness and intelligence. It aims to close the gap between stakeholders’ experience of the situation and their perception of their participation in the whole; seeing the system not as an external entity but as a product of their mutual relationships and their enactment of different social dynamics and patterns. This results in better understanding of the sources from which all social action comes into being and in doing so facilitate natural leadership for individual and collective transformational change.

Effect of restoration techniques on biogeochemical processes and biological structure of wetlands

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Single or combined, restoration techniques (plantation, soil addition, topographical modification, hydrological restoration or removal of invasive species) are widely used to achieve restored functional wetlands. However, the effectiveness of each technique to recover original lost wetland functions has not been globally evaluated. We performed a meta-analysis of 654 restored wetlands worldwide to estimate the success of every restoration technique over the time and the combined effect of the restoration techniques and the environmental setting (climate and hydrogeomorphology). Our results show that after 30 years, the introduction of plant material significantly increases biogeochemical processes to reference levels, but has no significant effects on the recovery of biological structure. Topohydrographical restoration had no significant effects on the recovery of the biogeochemical processes, but recovered the biological structure after 5 to 10 years. Hydrological restoration did not increase significantly either the biogeochemical processes or biological structure after, at least, 15 years. The addition of soil from similar wetlands recovered biogeochemical processes even after 5 to 10 years but had no effect on the biological structure. Climate and hydrogeomorphology significantly conditioned the success of some techniques. To recover wetland functions a combination of different techniques may increase the success of the restoration. Combining the introduction of plant material and soil might result in increased biogeochemical processes. Also, topo-hydrographical restoration might help to recover the biological structure. Due to the general lack of recovery in wetland restoration, a combination of conservation efforts and assessed restoration techniques would be needed to preserve wetlands functions.

Restauración basada en la aceleración de la sucesión, estrategia para el restablecimiento de la conectividad en paisajes rurales andinos Colombianos

Vargas, William G.; F. H. Lozano, G. J. Guerra
Universidad Icesi, Colombia

El restablecimiento de la conectividad, generación de hábitat, conservación de la biodiversidad y servicios ambientales son los ejes principales para el desarrollo de procesos de restauración en paisajes rurales. En 2003 se inicio el establecimiento del corredor Barbas –Bremen, un total de 68ha fueron intervenidas y transformadas en bosques a partir de potreros y plantaciones de coníferas. Se logró una rápida transformación del paisaje a un costo menor que la reforestación convencional y altos niveles de conectividad mediante el uso de herramientas de manejo del paisaje para la sostenibilidad socioeconómica y biológica de la propuesta. Un total de 498 especies de plantas nativas y 2,7 millones de individuos fueron propagados en vivero, de ellas 161 especies consideradas amenazadas de extinción. Plantones de hasta 7m de altura, obtenidos principalmente del interior de las plantaciones forestales, siembra de plantas no menores a 70cm, altas densidades de siembra y el uso de pioneras intermedias como especies
catalizadoras fueron claves para el éxito. Ocho años después estos bosques contienen cerca de 600 especies de plantas y alcanzan doseles cercanos a 18m de altura, la composición de mamíferos terrestres es similar que en los bosques de referencia y la composición de aves muestra la presencia de especies propias de formaciones más maduras. Procesos como este se han adelantado en otras regiones con éxito similar, siendo los viveros y las herramientas de manejo del paisaje los elementos claves.

**The ecological restoration group at the Universidad Nacional of Columbia (GREUNAL)**

**Vargas Rios, Orlando**  
Universidad Nacional de Colombia

The Group of Ecological Restoration (GREUNAL) at the Universidad Nacional of Colombia was founded in 2002. The group’s researches have been focused on ecological restoration experiences in the high Andean forest of the Eastern Colombian Cordillera, between 3000 and 3300 m.a.s.l., in places as Cogua’s City Hall Forestal Reserve and around the Chisacá reservoir, in the vicinity of BogotáD.C. In the high-Andean strip, it has worked on ecological restoration practices in: (a) abandoned pastures, (b) edges of relict forest, (c) invaded areas by gorse (*Ulex europaeus*) and (d) forest plantations of exotic species. The group has long experience in the management and restoration of areas invaded by gorse. Another ecosystem, studied by GREUNAL, is the Andean paramo where it has started experiments for restoring degraded areas by cattle grazing at 3400 m.a.s.l. These investigations have tested various strategies; the most successful one is transplantation of individuals of tussock grass and rosettes of *Espeletia* spp. Currently (2011), the Group has two projects, the first one assesses the actual state of plant invasions in thirteen wetlands of Bogotá D.C., and also designs restoration experiences for the wetlands edges using transplantation, vegetative propagation and seeding of native species of the zone. The second one is focused on the restoration of a micro watershed, located between 3200 and 3500 m.a.s.l., it mainly works on the restoration of riparian areas and in the participative process of the local community within the project.

**Ecological restoration in areas invaded by gorse (*Ulex europaeus L.*): An experience in the Columbian Andes**

**Vargas Rios, Orlando; Lina Estupiñán, Olga León**  
Universidad Nacional de Colombia

The gorse was introduced in Colombia in the 1900s and it has spread out in large areas of the tropical Andes. Since 2005, researches have been developing strategies to control the exotic species and practices of ecological restoration in rural areas of BogotáD.C. This study is focused on an ecological restoration model for invaded areas by this exotic plant. This research has three stages: In the first stage it was made a regional characterization of the gorse invasion, it was based on studies of the site conditions and small scale experiments. The second stage was the application of control practices and restoration experiences at local scale, as well as protocols for monitoring and management. The third and current stage is restoration planning at regional scale. In all stages local communities have been involved. Throughout the whole investigation it was studied how the invasion works (cyclic succession model). Related to this problem, it was proposed a State-and-Transition model which incorporates unfavorable transitions for the ecosystem. Finally, a successional model was designed for areas invaded by *Ulex europaeus*, including strategies for the establishment of native species in this Andean area. The suggested protocol parts are: 1 Remove epigeous and hypogeous biomass, 2. Control of soil seed bank (control phases), 3. Formation of herbaceous canopy gaps, 4. Make canopies of shrubs and trees, 5. Create patches for revegetation of one or several species, 6. Planting and enrichment with new native species.

**Escenarios y problemas institucionales para la implementación de una política de extracción de la carpa (*Cyprinus carpio*) del lago de Pátzcuaro**

**Vargas Velázquez, Sergio; Perla Alonso-Egüía Lis**  
Universidad Autónoma del Estado de Morelos, México

La carpa (*Cyprinus carpio*) introducida en el lago de Pátzcuaro ha tenido un impacto considerable en su ecosistema lacustre, afectando las dinámicas socio-cultural y económica de los pescadores. En este trabajo se analizan varias alternativas de extracción con fines de reducción de la población de carpa, mediante el análisis biológico de la población, análisis de la visión y uso por los pescadores y del mercado tradicional del lago, y el análisis económico de cuatro posibles escenarios de procesamiento y venta de la carpa. Se enfatiza en la problemática para la elaboración de políticas públicas viables, en una región que ha sido objeto de un gran número de intervenciones, sin que a la fecha se hayan logrado mejorar los indicadores ecosistémicos dentro del lago. Los resultados obtenidos indican que
la carpa es la especie predominante, a pesar de lo cual se calcula una biomasa reducida. Los pescadores perciben a este pez como el causante de la desaparición de especies nativas, poco apreciado por los consumidores y bajo valor de mercado, teniendo como consecuencia la reducción del número de pescadores activos. Se elaboró un programa de extracción y procesamiento como ensilado, como el escenario más viable para su extracción, pero se manifiestan las dificultades del arreglo institucional actual para un evaluar e implementar las alternativas más realizables para la restauración del lago.

Dos propuestas de conectividad ecológico-productiva para el piedemonte Andino-amazónico Colombiano

Vásquez Noriega, Pilar
Fundación Erawá, Colombia

Se presentan dos experiencias de diseño de conectividad ecológico-productiva en el piedemonte andino amazónico, Caquetá, Colombia, que tienen como objetivo mejorar la conectividad entre reductos de bosque y otras formaciones vegetales naturales o productivas. La primera en el municipio de Florencia. El paisaje está dominado por cobertura de pasturas con 52 %, fragmentos de bosque 19 % y abundantes humedales 21%. La segunda en el municipio de Belén de los Andaquies, contigua al Parque Nacional Natural Alto Fragua IndiWasi. El paisaje está dominado por la cobertura Vegetación Secundaria con 43 %, Bosques Densos 37% y Pasturas Límpias y Enmalezadas 20%. En el diseño de corredores se establecieron criterios productivos y ecológicos, tanto de conservación como de prestación de servicios. Para la selección de rutas se aplicó el Método de Menor Costo. (ArcGis 9.2 SpatialAnalyst, DistanceAnalysis) Se trabajó a dos escalas espaciales y temporales: regional y predial. La regional permite el diseño de redes potenciales entre fragmentos de bosque y áreas protegidas, mientras que la predial establece rutas cortas entre áreas prioritarias dentro de los predios, que se conectan en el corto plazo. Se trabaja con fincas donde se introducen elementos de producción sostenible combinados con la estrategia de conectividad A escala predial se diseñaron en Florencia 34 corredores, con 7.850 m de longitud, que conectan 168.7 ha de bosque y humedales. En Belén de los Andaquies 94 trayectos que conectan más de 4.000 ha de bosque.

Temporal priority over exotic annuals increases the establishment and persistence of California native perennial grasses

Vaughn, Kurt
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The invasion and continued dominance of exotic annual grasses in California has most commonly been attributed to their earlier germination and rapid initial growth relative to native perennial grasses. This germination advantage may play a crucial role in the current structure of California exotic annual grasslands, as well as in the practice of restoration of native perennial grasses in this system. I tested whether a two-week planting advantage, relative to annual grasses, increased the establishment success of four native perennial grass species under field conditions over three years. This short priority advantage significantly increased the establishment success, cover and total reproductive output of native grasses. However, the strength and persistence of these priority effects differed depending on the scale of the metric; community-level effects (density, cover, total reproductive output) were more pronounced and showed greater persistence over time than individual-level priority effects (individual size and individual reproductive output). I demonstrated that priority effects at the individual level may diminish over time, but that even short differences in emergence timing can have long-lasting effects on community structure. In addition, earlier germination may help explain the unprecedented invasion and continued dominance of California grasslands by exotic annual species. Finally, these results highlight the complex relationship between weed control and native grassland restoration in California: temporary weed control can increase the establishment of native perennial seedlings which then only then can result in long-term weed control by mature native individuals.

La restauración ecológica y su circunstancia en México

Vega Marrat, Jorge Enrique
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A diferencia de otras disciplinas de la ciencia, la Restauración Ecológica se enfrenta a problemas cuya solución requiere de un abordaje no exclusivamente científico-técnico o estrictamente biológico. Sin embargo, estos son abordados por ella de manera casi accesoria. Esto mantiene a la disciplina en una limitación frente al reto esencial de restaurar ecosistemas en el mundo de la realidad. Para evitar esta condición la disciplina puede plantearse la tarea de responder, desde un ejercicio autocrítico, algunas preguntas primarias que le permitan forjar un punto de partida
mucho más amplio sobre los retos a los que se enfrentará. ¿Cuál es su verdadera finalidad? ¿Cuál su circunstancia real y concreta? ¿Cuáles sus limitaciones? y, sobre todo, ¿Cuál es su papel dentro de las ciencias y frente a los problemas de degradación ecológica que nos aquejan? Esta reflexión en torno al origen, la naturaleza, los fines y los límites de la Restauración Ecológica puede contribuir especialmente al desarrollo de esta disciplina en México y América Latina. Desarrollar estas respuestas abre una vía para comprender nuestra particularidad y la naturaleza de nuestras posibles contribuciones al interior de nuestra disciplina. Este trabajo desarrolla un ejercicio de autoanálisis para clarificar el sentido e intención original de la disciplina y su circunstancia histórica real, enfocado especialmente en el caso mexicano.

**Project twin streams: An ecosystem service-based evaluation of an urban restoration project**

**Vesely, Eva-Tereza**  
Landcare Research, New Zealand

Project Twin Streams (PTS) in Waitakere City, New Zealand Aotearoa, is an award-winning environmental restoration and storm water management project whose purpose or kaupapa is working together for healthy streams and strong communities. To inform the evaluation and future planning of the project, an ecosystem service framework and impact pathway approach is applied to characterize and quantify the benefits associated with the product side of the outcomes of this restoration initiative. A list of potential ecosystem services is compiled and assessed in the context of the project and in the project’s absence. Relevant ecosystem services are characterized from spatial, temporal and ownership perspectives. In collaboration with an expert panel, the services are quantified in biophysical terms. Finally, to indicate the order and relative magnitude of the monetary value of changes resulting from PTS in the delivery of ecosystem services, the benefit transfer technique is applied. The estimated values are then aggregated over space and time in a workshop setting. In this presentation I will describe the process we undertook for the assessment of this restoration project, the result of the assessment and discuss the combined presentation of the product and process components of the restoration outcomes. Based on insights gained from the framework development and application, I will make a series of reflections about both value creation and articulation in this urban restoration project.

**Are there suitable monitoring methods to protect endangered shrub swamp communities?**

**Vickers, Helen**  
University of Queensland, Australia

A long-term study undertaken in the Western Blue Mountains of New South Wales, Australia, examined the potential impact of underground coal mining activities upon the endangered shrub swamp communities of the Newnes Plateau. The study investigated changes in abundance, diversity and condition of vegetation within these swamps over time. Floristic surveys using a modified Braun-Blanquetter cover/abundance scale, in combination with condition assessments, were undertaken in plots across a range of swamps both before, and after, long-wall mining panels were extracted. Background levels of species diversity, vegetation condition, exotic species abundance and cover of Eucalypts of relatively undisturbed sites were used as controls to determine whether potentially impacted swamps fell within the range of values found in non-impacted swamps. No clear trends, with the exception of an increasing abundance and richness of exotic species at sites impacted by mine water discharge, were found at sites that had been undermined. Monitoring methods were driven by environmental regulations that require potential impacts on the composition or health of this endangered ecological community to be assessed. This dataset has allowed monitoring methods to be assessed and we found that spatially aware survey methods are required to provide confidence that potential impacts, which fall outside the current plot-based system, can be detected rapidly.

**Rewilding the South China tiger (Panthera tigris amoyensis)**

**Viljoen, Petri; Gary Koehler, Jim Sanderson**  
Save China’s Tigers, China

The South China tiger (Panthera tigris amoyensis), endemic to China, is the most endangered of the remaining five living tiger subspecies. If the South China tiger still exists at all in the wild, it is extremely rare. Captive facilities in China contain approximately 90 individuals. The only South China tigers available for possible free release into protected areas are from the captive-born population. The background, progress and future plans for the re-establishment of the South China tiger into its natural habitat are described. Five young South China tigers were initially relocated from Chinese zoos to Laohu Valley Reserve in South Africa as part of an ex situ rewilding strategy to teach captive-born tigers to hunt independently prior to their planned free-release into suitable areas within the
species’ historic range in China. South Africa was selected for the rewilding program, particularly because of the availability of potential wild prey species and local wildlife management expertise. The captive-born tigers successfully hunted blue buck (*Damalisus dorcas*) during the initial period in game-proof fenced enclosures. This demonstrated that young, captive-born tigers quickly learn basic hunting skills. The development of the planned tiger reserves in south-eastern China will include habitat restoration and the establishment of an adequate, natural prey base prior to release of tigers. Reserves will also be game-proof fenced to avoid the possible dispersal of tigers into the surrounding communities.

**Growth and survival monitoring of 10,000 trees planted on the Ecological Restoration Project of Regional Metropolitan Natural Park “Cerro El Volador” in Medellin, Colombia**

**Villegas Vélez**, Felipe; **Tomas Hinestroza Koppel**, Cristina López-Gallego, **Felipe Cordona**

Universidad de Antioquia, Colombia

Regional Metropolitan Natural Park “Cerro El Volador”, located in Medellin, Colombia, has been reported to have human activities since pre-colonial times; in consequence, its ecosystems are heavily degraded and filled with invasive species. The Park is a green area of 107 ha immersed in the city; its mean temperature is 19.5°C and it shows a relative humidity of 79% with altitudes ranging from 1450 to 1628 m.a.s.l. In 2009, the Secretaría del Medio Ambiente de Medellin and the Herbarium of the Universidad de Antioquia (HUA) began a project of ecological restoration which included planting over 10,000 trees of more than 100 native forest species and applying 5 experimental fertilization treatments. Effects of these treatments on tree height and diameter growth rates as well as survival were evaluated during two monitoring stages, beginning on April 2010. Significant effects of the experimental treatments on growth rates were found on 23% of the evaluated species whereas environmental conditions had an effect on 76% of them. 20% of the individuals planted were reported as dead, but mortality varied notably along species. Promising species for restoration were identified, mainly pioneers in families such as Fabaceae, Meliaceae and Hurticaceae, most of them from pre-montane dry forest life zones, which due to their higher growth rates and low mortality can be appropriate for other projects in areas with similar conditions.

**Tree species functional traits as a tool to restoration ecology of Atlantic forest fragments**

**Villela**, Dora Maria; **Eduardo Arcoverde de Mattos**, Karla Pedra Archanjo, **Ana Paula da Silva**, **Marcelo Trindade Nascimento**

Universidade Estadual do Norte Fluminense, Brazil

The Atlantic forest is a biodiversity hotspot despite the current reduction of 7% of its original extension on the Brazilian coast. Concerned with the species loss caused by deforestation and fragmentation, this study aims to propose species which may be used in enrichment programs of impoverished Atlantic forest fragments, based on the functional traits of tree species. Four 13-55ha and one 1.190ha fragments of semi-deciduous Atlantic forest were selected at Rio de Janeiro State, Brazil. Floristic composition, phytosociological and eco-physiological parameters, and leaf nutrient concentrations were determined for the main tree species in each fragment. The high nutritional quality of *Alseis pickelli*, *Metrodorea nigra* and mainly *Paratecoma peroba* leaves, calls attention to the importance of these species in the nutrient cycling of those fragments, possibly promoting enrichment of surface soils. The variation of the morpho-physiological traits supports the idea that there is a large functional richness among the abundant species. This diversity of functional traits should be related to different response strategies to heterogeneity of light, water and nutrient availability. This indicates that Atlantic forests restoration programs must consider species with a variety of functional traits that allow the species to a complementary use of resources. The application of forest enrichment techniques using late secondary species which present nutritional and eco-physiological traits important to ecosystem function and response to environmental conditions and resource heterogeneity, is relevant. They may act as key species in the recovery process of those fragments.

**Factors determining the presence of bat species in secondary forest under traditional management in Lacanhá, Selva Lacandon, Chiapas, Mexico**

**Vleut**, Ivar; **Samuel Levy Tacher**

El Colegio de la Frontera Sur, México

Bats are known for their contribution to the regulation of herbivory, pollination and seed dispersal or predation in tropical forests. However, the rapid conversion of mature forests into agricultural areas and consequently secondary forest can have considerable consequences on provision of these ecological services, leaving fragments of mature vegetation and limiting refuge or foraging possibilities. The management of terrains of the Lacandon people in the
community of Lacanhá can be considered exceptional in comparison to the majority of the communities in the surrounding area. The farmers of the community of Lacanjá Chansayab apply a sustainable form of slash-and-burn management which permits the persistence of a matrix of mature vegetation, with patches of agricultural fields and secondary forests. This exceptional condition where secondary forests areas are partially or completely surrounded by mature vegetation presents an interesting situation to study bat assemblage. Bat assemblage was studied in areas of secondary forest of, completely (>75%) or partially (<50%) surrounded by mature vegetation. Bat diversity and richness were positively related to the proportion of surrounding mature vegetation in secondary forest areas. Frugivorous bats feeding on fruits from shrubs dominated in secondary forest partially surrounded by mature vegetation, while bats feeding on fruits from pioneer or climax trees dominated in secondary forest areas completely surrounded by mature vegetation. The proportion of mature vegetation surrounding secondary forest seems to affect the assembly of bats within secondary forest and therefore their probability to provide ecological services, implying the importance of mature vegetation surrounding degraded areas.

Politics and ecological restoration in urban areas: A view from discourse analytics
von Bertrab, Alejandro
Universidad Nacional Autónoma de México

Ecological restoration is as much a field of techno-scientific solutions for reversing ecosystem degradation as it is an arena of politics. Ecological restoration project design and implementation pit different visions about nature against one another. This occurs more acutely in urban contexts where land and water, and what they contain, can mean very different things to different people. Concepts such as degradation or ecosystem integrity may be questioned and confronted. This can force planners, supporters and opponents alike to revisit their agendas and even open them to public scrutiny. Discourse analytics is a tool of social inquiry that questions the validity of universalistic truth claims and looks into the power relations inherent in the construction of notions about nature and the institutions that support them. By analyzing the verbal and nonverbal expressions of social groups engaged in particular ecological restoration projects in specific time periods, discourse analysis aids in discerning groups’ strategic behavior in attempting to influence decisions, detect traits of dominant ideas about nature in specific historic periods and understand how notions interact to form new meanings and shape project outcomes. Assessing ecological restoration through the various discourses that shape and are shaped by this practice poses the challenge of accepting that one’s view of nature, as a restoration practitioner, is just one among many. Project design and outcomes may reflect a messy negotiated process instead of a linear endeavor based on apparently value free scientific principles.

Why consider seed dormancy and germination when designing ex situ seed banking for ecological restoration?
Walck, Jeffrey
Middle Tennessee State University, USA

Understanding seed dormancy and germination of species is crucial for high success of seed-based restoration projects. Complete dormancy loss producing high percentages of germination is desirable for a broad array of genotypes to be represented in projects. However, seed dormancy often hinders plant propagation. Although forced (unnatural) dormancy loss (e.g. with gibberellic acid) provides quick germination for seeds of many species, vigor of the resulting seedlings often differs from that of seedlings with natural (or near-natural) dormancy loss. Seed-based restoration projects are ecologically and evolutionarily most-relevant if they are matched to the life cycle of plants and to environmental cues. For example, the timing for sowing seeds from an ex situ seed bank could occur during the dispersal season of the species so that dormancy loss occurs in the field and germination occurs at the optimal time in nature. To this end, phenological information should be a vital component of restoration projects. However, as climates change and novel climates are formed finding the most favorable thermo-moisture balance for dormancy loss and germination may become increasingly difficult. Knowing the tolerance ranges for dormancy loss and germination, and the adaptability/plasticity of these traits, would be of tremendous assistance in designing future collection strategies for seed banking. Moreover, seed bank practitioners will need to team-up with climate/ecological modelers to find environments that fulfill requirements for seedling establishment under future climate conditions.

Linking landscapes – A continental collaborative vision for Australia
Walker, Ian; Ian Pulford, Graeme Worboys
Parks Victoria, Australia
This paper describes the Linking Landscapes Collaboration and its role in shaping resilient communities and landscape by encouraging large-scale connectivity conservation initiatives across the Australian continent. The Collaboration was initiated in November 2009 when leading Australians and organizations came together and developed a shared vision to conserve and interconnect Australia’s natural and cultural lands. The vision stated: To reverse the decline in biodiversity through the delivery of landscape scale collaborative connectivity conservation initiatives, for the long-term economic, social, cultural, health and spiritual wellbeing of all Australians. The Collaboration recognizes an urgent need to respond, at large scale to; the serious decline in Australia’s unique native species and ecosystems; the effects of climate change; and the health and wellbeing of regional Australians. Actively managed, strategic, continental scale native vegetation linkages that cross a range of tenures are a critical response to these challenges. These linkages offer major gains for biodiversity conservation, climate change adaptation and mitigation, sustainable land use, employment and health outcomes. The Collaboration is encouraging these linkages and there is progress. In 2010, across at least 20% of Australia connectivity conservation initiatives have helped interconnect protected areas, biodiversity hotspots and many Bioregions. Some of these initiatives include Gondwana Link, Great Eastern Ranges, Habitat 141°, and Trans Australian Ecolith. Supported and encouraged by the Linking Landscapes Collaboration these initiatives are a first step towards designing and implementing a national plan for the conservation of Australia’s biodiversity and wellbeing of all Australians.

Reducing grazing pressure for the recovery of semi-arid woodlands in the Victorian Mallee National Parks, Australia

Walker, Ian; Peter Sandell
Parks Victoria, Australia

This paper explores the long-term restoration of semi-arid Woodlands in the Victorian Mallee, Australia. In 1991 the Mallee National Parks were expanded following a history of grazing and clearing across most of north-west Victoria. The establishment of these parks conserved areas dominated by mallee, mallee-heaths, dry woodlands, and chenopod shrublands. These latter two communities had been preferentially cleared and those areas remaining on public land were degraded by a long history of stock grazing and periodically high rabbit abundance. The dependent fauna was depleted with a legacy of local extinctions. The history of grazing and the provision of artificial water sources resulted in an explosion in kangaroo and goat densities after destocking and an inherited broad scale rabbit problem across in excess of 200,000 hectares. With this level of total grazing pressure there was no prospect of natural regeneration of the key woody perennials such as Slender Cypress-pine, Buloke, and Belah. “Restoring the Balance”, was implemented from 1992 with the objective of restoring degraded woodlands through the effective reduction of total grazing pressure. Grazing pressure was progressively reduced and threat reduction targets achieved with the assistance of the arrival of Rabbit Hemorrhagic Disease virus in rabbit populations in 1996. Subsequently there has been considerable evidence of regeneration of woody perennials. The establishment of clear objectives and a long term plan have enabled key outcomes to be achieved. The challenge of climate change and predation by foxes are the next hurdles for restoration of these parks.

Habitat 141° - A community vision, connecting people and nature

Walker, Ian; Ben Carr
Parks Victoria, Australia

This paper explores the development of Habitat 141° a large scale, long term landscape initiative to safeguard the natural and associated agricultural environments along the Victorian, South Australian border by protecting and enhancing key natural and cultural values across all land tenures. Habitat 141° extends over 20,000 km²s along longitude 141°. The vision for Habitat 141° came from the initial stakeholder meeting in 2008. This vision “to work with communities to conserve, restore and connect habitats for plants and wildlife on a landscape scale from the outback to the ocean” is a powerful statement of intent and a challenging goal that will continue to drive the development of Habitat 141°. The unique feature of this landscape initiative has been the explicit engagement of people - communities, Traditional Owners, non-government organizations, scientists, governments (national, state and local) , commercial and philanthropic partners as equals. It is the alignment of people’s passion that is connecting key ecosystems including heathlands, mallee, red gum forests and grassy woodlands. Habitat 141° also interconnects with World and National Heritage sites, Ramsar sites, and National Parks and also contributes to the maintenance or recovery of hundreds of threatened species and communities. Habitat 141° uses the Nature Conservancy’s Conservation Action Planning process within nine landscape zones to plan strategic conservation actions. The restoration is carried out by a wide variety of organization with funding from different sources.
Environmental justice and the politics of restoration in two Ontario communities

Wallace, Lisa
York University, Canada

This paper examines the rehabilitation of post-industrial land from an environmental justice perspective. Environmental justice advocates explicitly link ecological degradation and social inequality by recognizing the disproportionate adverse effects of environmental burden on marginalized populations, and the movement has achieved important gains in reframing environmental issues to include a human and equity dimension. A focus on pollution and siting concerns has historically precluded an environmental justice analysis of the restoration of former industrial lands. However, both a substantive (distributive) and procedural (process-focused) environmental justice approach can illuminate the important, but often-overlooked, equity dimensions of restoration. The disparate rehabilitation of two aggregate extraction sites in Southern Ontario provides a case study. Originally slated for large-scale residential and commercial development, one site now includes a wetland complex and environmental education centre. The other site, by contrast, will almost certainly house a development even though residents initially called for a park. Drawing on community interviews, archival research, and analysis of government and policy documents, the paper explores the role of rehabilitation planning in accounting for the disparity. It concludes that the planning process often favours well-connected communities but also finds that traditional procedural environmental injustice may interact with more “contingent” factors such as location, timing, and other social forces to produce inequitable outcomes. The analysis foregrounds the significance of process to outcome for both restoration and environmental justice, with important justice implications for restoration in other communities and industries.

Restoration of the semi-arid Australian rangelands requires multiple approaches that allow for the integration of biodiversity and primary production at a number of scales

Waters, Cathleen; R B Hacker, R Kavanagh
Industry & Investment New South Wales, Australia

Natural resources and biodiversity are declining at fast rates within the semi-arid rangelands of eastern Australia. Restoration of processes essential to ecosystem function and the biodiversity which underpins it is central to rebuilding functioning landscapes. This paper highlights significant recent advances in management activities to restore ecosystems function within these areas. Management activities that provide partial solutions are considered within a framework that allows trade-offs between private and public benefits. Activities where private and public interest may be compatible include the use of pasture cropping technologies and the enhancement of natural processes to facilitate seed supply for revegetation. In cases where public and private interests are likely to be incompatible, financial incentives such as the ground cover-based incentive approach to change grazing management practise can be used. We identify the central role landscape heterogeneity plays in the restoration of ecosystem function. Water-point management, enhancement/management of remnant vegetation and invasive native shrub management are identified as activities that may led toward greater landscape heterogeneity. The application of Bayesian Networks provides a tool for optimising the design of landscapes in terms of the allocation of land units to competing land uses (e.g. conservation vs. grazing) and the spatial arrangement of land-use.

Prickly plant, prickly problems: Success and failure in the recovery of Ziziphus celata, an endangered shrub of the Lake Wales Ridge, Florida, USA

Weekley, Carl; Eric S. Menges, Stacy A. Smith, Sarah J. Haller, Brian J. Poirier
Archbold Biological Station, USA

Recovery of an imperiled plant species may require augmentation of existing populations or creation of new ones. Hundreds of such projects have been conducted over the last few decades, but there is a bias in the literature favoring successes over failures. Since 2002, we have carried out three augmentations and five introductions of Ziziphus celata, a clonal shrub narrowly endemic to pyrogenic central Florida sandhills. Each augmentation/introduction was designed as an experiment to test hypotheses about demographic and genetic performance, microhabitat preferences, response to fire, and translocation techniques. In evaluating each project, we document failure as well as success. Demographic successes include annual survival and post-burn resprouting rates comparable to wild populations, while failures include lack of vegetative or sexual reproduction and low rates of seed germination and seedling survival. Translocation propagules representing different maternal lineages have been equally successful, although transplants have been more successful than seeds. Contrary to expectation, introduced propagules have not been
more successful in unshaded sites, suggesting that *Z. celata* has broader microhabitat preferences than hypothesized—a beneficial failure of conjecture. While no translocated population has demonstrated a capacity for long-term viability, one population has flowered and produced viable fruits. Given that *Z. celata* genets are long-lived, low levels of sexual reproduction may be adequate for the establishment of viable populations. Thus, after eight translocations within a decade, it is premature to characterize any single translocation as a success or a failure, underscoring the need for a long view of translocation success.

**Habitat restoration in the Southern Peruvian desert - An ecosystem approach**

Whaley, Oliver; David Beresford-Jones, Consuelo Borda
Royal Botanic Gardens, Kew

The desert of southern Peru has undergone almost total deforestation of Prosopis woodlands, severely impacting biodiversity and livelihoods. Human populations have grown rapidly through Andean immigration supplying labor to coastal development and agro-industrial expansion, thus society has become dislocated from natural resource management. However, relics of vegetation, traditional agriculture and agrobiodiversity still sustain ecosystem services and offer livelihood options and resources for restoration. These aspects reflect a long cultural trajectory (including famous extinct cultures such as Nasca) that included processes of plant domestication and adaptation to climatic oscillation. Here we present an ecosystem approach to vegetation restoration and sustainable resource management in Ica, in which school, community and agro-industry engagement is seen as a prerequisite for success. Since 2005 the project (including a Darwin Initiative grant) made detailed biodiversity surveys and mapping, set up restoration trials and conservation areas (in agroindustry lands and government concession); developed novel methods of plant establishment using appropriate low-tech and minimum watering techniques. Cultural engagement included the development of sustainable forest products, Huarango festivals, schools programmes, and didactic publications for local use. Today, the dedicated local team and tree nursery continue to develop propagation and restoration techniques for useful native plants (*e.g.* Prosopis, Capparis, Inga, Tecoma), producing c. 15,000 seedlings/year for it's community planting programme that includes monitoring of plant survival and recruitment (flora and fauna), training several hundred children and adults.

**Interweaving of cultural vitality and ecosystems**

Whittaker, Ruth
The Confederated Tribes of the Umatilla Indian Reservation, USA

The Confederated Tribes of the Umatilla Indian Reservation - Department of Natural Resources (CTUIR-DNR) is restoring riparian buffers along four major river systems. CTUIR – DNR and the Department of Science and Engineering, CTUIR-DOSE, are performing both research and restoration in shrub-steppe ecosystems. Using salvage, relocation, propagation, and minimized herbicides/mowing, CTUIR-DNR is collaborating with the United States Forest Service to protect culturally significant plants at ancient tribal campsites and with the Oregon Department of Transportation along state roads. European people, competing for one earth here in the intermountain region of the northwestern United States, altered the living landscape beyond usability by those whose lives were interwoven year-round with native plant communities: gathering of foods and fibers, medicines, fish, and meat through the seasons. Land surveyed and owned, farmed and grazed, curated gathering by those whose trail lives were ruled by seasons and salmon, celery root and camas, hemp dogbane and bitterroot [named *Lewisia rediviva*, for it burst into bloom after many dry months inside Lewis and Clark’s herbarium - tenacity all species need]. Pure cool water for anadromous fish runs relied on intact riparian plant communities; water must be shaded and sprinkled with life and oxygen by plants. In the beginning, ‘First Foods’ saved the Cayuse, the Walla Walla, and the Umatilla people; now we save them. Youth eagerly join elders in knowing where they have been and where they are going. Restoring ecosystems spawns cultural revival.

**Build it and they will come, but who? and how?**

Wiens, John
PRBO Conservation Science, USA

The notion of “build it and they will come” underlies both efforts to restore natural ecosystems and measures to set aside protected areas for conservation. The assumption—that “they will come”—is critical to the eventual success of both endeavors. Although considerable attention has been devoted to how to restore or protect places, how or whether “they” will then arrive and successfully colonize has received less attention. The contributions to this
symposium will address this shortcoming and I, in turn, will summarize and synthesize the points that emerge from these contributions.

**Restoration ecology and recovery from disturbances: Two sides of the same coin?**

*Wiens, John*

PRBO Conservation Science, USA

Restoration ecology and assessments of recovery from environmental disturbances have traditionally been separate fields of investigation, but their similarities run deep. Both consider the improvement of the ecological condition of a system over time following a degradation of that condition. Both have often established targets based on historical “ideal” reference conditions. With restoration, however, the degradation may have occurred over a long time and improvement is brought about by active intervention, whereas environmental disturbances are often single disruptive events and recovery is usually observed rather than managed. Restoration usually begins with damage or injury to the system as a given, whereas with environmental disturbances it is necessary to determine whether damage or injury has occurred before recovery can be assessed. After reviewing the similarities and differences between restoration and recovery analysis, I consider the issues raised in evaluating the recovery of ecological systems in Prince William Sound, Alaska, after the Exxon Valdez oil spill to evaluate whether the lessons learned there bear on how we think about ecological restoration in a dynamic environment. With the Exxon Valdez spill, there were disagreements about how “recovery” should be defined (e.g., as a return to pre-spill conditions), what criteria should be used to assess recovery (e.g., the status of individuals, populations, or habitats), and how studies should be designed and statistical analyses conducted. As restoration becomes more difficult in a changing world, insights from assessments of ecological recovery from disturbances may become increasingly relevant.

**Restoration opportunities in California’s agricultural landscapes: Native forb mix success at different densities**

*Wilkerson, Marit*

University of California, Davis

In California’s Central Valley, restorationists are focusing increased attention on planting native species in hedgerows along once bare or weed-infested field margins. In conjunction with pollinator services research, this study examined how three native forb seed mixes succeeded in hedgerows. At six farms, three seed mixes were planted in winter 2008 at three different densities (1x, 2x and 4x). We specifically examined germination success, amount of cover, flowering rates, and cost-effectiveness, important considerations for restoration and ecosystem services. During the growing seasons from 2008-2010, the type of mix, seeding rate, and site location were all significant factors for most planted species. A strict majority (five out of nine) of species had a higher germination rate and cover in mix 3, which contained all nine species, but the other four species often did best in mix 2 which contained only five species. Surprisingly, many species had just as high or higher rates of germination and cover at a seeding rate of 2x as they did at the highest seeding rate of 4x. Three species were the most cost-effective species in terms of density and cover throughout the growing season. However, those species were not always the most prolific bloomers. These multi-year results demonstrate the importance of seed mix and the “right” density for both restoration and ecosystem services projects. Practitioners also must consider specific project objectives, cost-effectiveness vs. flowering rate vs. germination success, when determining which mix to plant at which rate.

**The carbon neutral reclamation of an abandoned silver mine with biochar - Preliminary results from The Hope Mine**

*Williams, Morgan; Andrew Harley*

Biochar Reclamation Labs, USA

The accumulation of soil carbon using natural recovery techniques is a slow process, and a successful restoration program attempts to accelerate the natural recovery process to build long-term carbon storage. Biochar has been proposed as a potential amendment for the reclamation of mine lands to aid in the development of soil organic carbon, increase soil water holding capacity and vegetative cover, reduce the leaching of metals and volatiles into surface and groundwater, and stabilize slopes to reduce wind and water erosion. However, significant obstacles to large-scale reclamation with biochar remain, and few scaled reclamation trials using biochar have been conducted. The Hope Mine biochar restoration project is located within the White River National Forest of Colorado, USA. The abandoned silver mine consists of several steep waste rock outcrops containing harmful metals and volatiles that extend to Castle Creek, the main drinking water supply for the area. In the fall of 2010, a scaled biochar research trial
was implemented at the site. Biochar application rates from 2.5 to 20 tons per acre were tested along with the effectiveness of biochar with other amendments including compost and mychorrizal fungi for the restoration of steep waste rock slopes. Measurements of plant diversity, percent cover, and total yield from the first year of monitoring are described along with an evaluation of biochar handling techniques, technical hurdles, carbon sequestration potential, and technology costs.

The biodiversity-route

Winkler, Insa; Helen Harrison, Newton Harrison, Wolfgang Haber, Gernot Boehme
Leuphana University, Luenburg, Germany

Since monoculture is expanding worldwide the loss of bio- and cultural diversity in the constitution and composition of the landscape has dramatically increased. Agriculture has been replaced by Agro business. In the concept for integrated environmental monitoring Wolfgang Haber calls for making real conditions of our existence and to conditions of human action, because otherwise "the authoritative instrument of nature of the evolution also applying to the extinction of humanity." Due to the typological characterization of biotopes (Surkopp), Gernot Boehme speaks of an almost totally rebuild of nature that is also giving new challenges to rescue diversity. How may we activate participative understanding of the connection between bio and cultural diversity? To expand the idea “The Green Heart of Holland” and “Peninsula of Europe” of the Harrisons Studio envision structures and strategies towards the need for wider public environmental knowledge and action. Artistic eco pedagogy may become a catalyst for communicating the reorganization of ecosystems. The project “biodiversity - route” offers tools and methodologies for deep understanding of life patterns. It promotes the re-communication of cultural neighborhoods through collective research on biotopes. In transdisciplinary interactions of scientists, artists, children and teachers, in site-specific connections and through the educational relevant archetypes of human and nature, e.g. “Metamorphoses of the Plants” (Goethe) an expanded idea of biodiversity will appear. “We humans giving the land of asylum, we become the defenders of the cultural space of biological diversity, analogue for humans and cultural diversity.

Pyramid Lake natives: A collaborative tribal program effort to meet restoration needs on the lower Truckee River

Winemucca, Janine
Pyramid Lake Paiute Tribe, USA

Population growth in the western United States continues to steadily rise resulting in increased water usage in northern Nevada’s tributary systems. The Lower Truckee River, which supplies water to the cities of Truckee, Reno and Sparks, terminates in Pyramid Lake, which is governed by the Pyramid Lake Paiute Tribe (PLPT). The Truckee River serves many environmental purposes, such as maintaining in-stream flow for fish habitat, providing wetlands water, and sustaining Pyramid Lake fisheries. Pyramid Lake’s declining lake level has adversely affected the hydraulics of the Lower Truckee River, resulting in bank erosion, and the creation of a large delta where the river enters the lake. In addition, spawning gravels have become heavily silted, resulting in low egg survival for the threatened Salmo clarki (Lahontan Cutthroat Trout) and endangered Casmistes cujus (Cui-ui). The PLPT’s Environmental Department supervises two programs: the Weed Warriors and the Woodlands Project. The Weed Warrior’s combats invasive plant species with manual, chemical, clipping and chainsaw methods. The Woodlands Project identifies culturally-significant plants to the PLPT and incorporates these plants into the restoration of sandbars and barren river banks. Ongoing restoration efforts compliments the long-term goal of reestablishing healthy ecosystems on the lower Truckee River simultaneously promoting healthy plant material for tribal basketry, cradle boards, dance regalia, and medicinal use. Chosen plant material is environmentally and culturally important for tribal economics. Managing water in the western United States is a balancing act between PLPT’s Environmental Department, agencies, and landowners.

Restorative narratives: Why don't SER stories make headlines?

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Children need stories to learn about the world, and the desire for narratives remains with us all our lives. This desire drives the media, from celebrity tabloid trivia to broadsheet investigations. The myriad stories of ecological restoration projects and restoration ecology theories told at SER conferences hold great drama, but somehow they are not being heard very much outside restoration circles. Part of the problem is organizational -- without a specialist media executive it is hard to make an impact on media organizations with ever-shorter attentions spans. Part of the
problem is that good news is no news in a sensation-hungry media universe -- the environmental stories that get most attention are those that focus on catastrophes. Restoration stories tend to be positive, and they tend to be very slow-moving, and so remain beneath the radar. But unless the public knows what restorationists are doing, restoration policies will not gain public support. Yet there is plenty of drama, conflict and reconciliation, environmental and human, behind most important restoration stories. I have just finished a book based on the most compelling narratives I have encountered over several years' research: Working for Water brings together old enemies in post-apartheid South Africa but often divides scientists; citizen restoration in Chicago discovers a lost ecosystem but sparks furious civic controversy. And so on. I hope to bring these dramas to a wider audience, and to make some small contribution to giving restoration the profile it deserves.

Payments for environmental services as a tool for ecological restoration
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Payments for environmental services (PES) are a direct, conditional conservation instrument, exhibiting promising prospects for halting degrading or preserving environmentally friendly land uses. PES have been applied with some success in both developing and developed countries, primarily for carbon mitigation and watershed protection services, and to some extent for protecting biodiversity and recreational landscape values. Basically, the recent popularity of experiments with direct quid pro quo PES tools comes at the backdrop of generally poor results in applying in an isolated manner command and control conservation policies, as well as equally disappointing outcomes of more indirect integrated conservation and development projects (ICDPs). PES as the frontrunner of a conditional conservation paradigm carry the promise of becoming both more effective and more equitable interventions, by having winners compensate losers. Most real-world PES applications have been in enhanced forest conservation. However, some PES schemes have also been used for the purpose of inducing ecological restoration: reforestation, adoption of agroforestry, silvopasture and organic agriculture, and passive set-aside regeneration of degraded areas. In some cases, the productive systems using these new land-use covers are supposed to be more long-run profitable in the own right, yet punctual PES incentives could still be a way to overcome risk- and liquidity-induced barriers to their adoption.

Management strategies in addressing habitat degradation and fragmentation in a tropical mesic forest reserve on the island of Kauai, Hawaii
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Division of Forestry and Wildlife, State of Hawaii, USA

Due to extreme isolation, the Hawaiian Islands boast the highest rate of floral endemism in the world with 90% of the native vegetation unique to the archipelago. However, the presence of feral ungulates in Hawaii and the introduction of non-native invasive species have led to the degradation and fragmentation of native forest habitats over the past 200 years. Currently much of this unique flora as well as the habitats that support them are now critically imperiled. The Natural Area Reserves System (NARS) is a program of the State of Hawaii Division of Forestry and Wildlife established in 1970 to preserve in perpetuity native communities of the natural flora and fauna of Hawai‘i. On the leeward side of the island of Kauai, the Kuia Reserve consists of 1,636 acres of tropical mesic forest unique for its high level of endemism and high concentration of rare plants. Addressing program goals for habitat protection, ecosystem restoration, and endangered species recovery across this degraded and fragmented reserve has posed serious social, economic, political and cultural challenges for managers and scientists. Over the past 5 years, considerable progress has been made towards achieving these goals. Solutions have focused on actively engaging the public and stakeholders from the planning stage through implementation. On-the-ground management has combined tried and true techniques such as feral ungulate exclusion, invasive weed control, and native species planting with active community outreach and education.

Social perceptions and environmental communication on the ‘benefits’ and ‘risks’ of tidal flat restorations: Case studies from Japan
Yamashita, Hiromi
Nagoya University, Japan

Various tidal flat restoration projects have been conducted in Japan in recent years. However, the criteria of what constitutes ‘restoration’ are not clearly defined, and the indicators used to evaluate restoration projects are often merely based on quantitative data, such as the increase in numbers of a particular species after a project. Coastal
Restoration seed banking with limited resources

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University of Hawai'i, USA

Seed banking for landscape restoration requires seed banks far larger than most existing banks. However, seed banking is a very scalable activity. Where resources are not available to establish large scale seed banks immediately, it is practical to start small-scale banks that can gracefully expand into larger banks as more resources become available. This is because, in most habitats, most seeds are "orthodox", i.e. their storage life can be greatly extended by storing them at controlled low temperatures and moisture levels. Storage techniques for such seeds are simple. Most of the equipment needed to start a basic facility for storage of orthodox seeds is readily available from household and agricultural suppliers. A small technical staff can direct a sizeable local force. Much of the information and staff training materials necessary to store seeds successfully are now readily available at no cost on the Internet, especially from the Kew Millennium Seed Bank and Bioversity International. We explain how a local seed bank can be started using ordinary home refrigerators and freezers, simple equipment, and an initially untrained local staff. As an example, we present a case study of how a successful conservation seed bank for seeds of endangered Hawaiian plants was established at a time when almost nothing was known about storage properties of Hawaiian plants and few resources were available.

Ecodynamic solutions for the protection of intertidal habitats: The use of oyster reefs

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Ecosystem engineers are organisms that change the abiotic environment by physically altering structure. As a consequence they often have effects on other biota and on ecosystem processes. The physical ecosystem engineering concept interconnects a number of important ecological and evolutionary concepts and is particularly relevant to environmental management. Within the Dutch innovation program Building with Nature we investigate the use of bivalve reefs as possible ecodynamic measure for the stabilization of tidal flats and shoreline protection. Bivalve reefs are ecosystem engineers that influence tidal flow and wave action and, in doing so, modify patterns of sediment deposition. At the same time these reefs form valuable habitats that play an important role in shaping estuarine landscapes. After several lab and field experiments, three large, experimental, artificial reefs (200m long, 10m wide) were constructed in the Oosterschelde estuary (SW Netherlands) in 2010, consisting of gabions filled with oyster shells of the Pacific Oyster, Crassostrea gigas. These structures offer a stable substrate, that allows for settlement of oysters, while minimizing shell loss from waves and currents. If successful, the artificial reefs will develop to living oyster reefs that form a viable and cost-efficient way of stabilizing tidal flats, which is also adapted to sea level rise. A multidisciplinary monitoring program on the development of the reefs and their ecomorphological effect revealed site specific effects. Knowledge about local hydromorphological conditions and a thorough understanding of the ecosystem engineering properties and habitat requirements of the Pacific Oyster is needed to implement this concept in management practices. We present in more detail the concept and show first results from the pilot experiments.

How to link urban river restoration with ecohydrology criteria and water footprint standards?

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This paper aims to show how ecohydrology and grey water footprint are related to urban river restoration. The water footprint standards, proposed by Hoekstra et al (2011) are composed by four phases: (1) Setting goals and scope, (2)
Water footprint accounting, (3) Water footprint sustainability assessment, and (4) Water footprint response formulation. The second phase is related to assess green/blue/grey components and the fourth to mitigation-and-adaptation guidelines, including ecosystem restoration. The grey water footprint refers to the equivalent amount of water to dilute the load of pollutants above a quality standard in a water body. Ecolhydrological criteria (Mendiondo, 2008) encompass qualitative-quantitative relationships and functions to enhance river biodiversity among managing pollution loads, flow discharges, water levels, and active areas of floodplain during pulses and duration curves. Zaffani et al (2010) discuss the strengths and limitations of ecolhydrological strategy in the scope of experiments and modeling. The working hypothesis to link decreasing load-discharge curves, between urbanized and reference conditions, as a viable restoration goal. At the water footprint response formulation phase, load pollution decrease is equivalent to a reduction of grey water footprint. Not only in situ experiments, but also river quality modeling (SWMM) are performed at urban catchments in São Carlos City, SP, Brazil. Preliminary results address on how water footprint estimation can link ecolhydrology and restoration goals into future environmental policies, i.e. through incentives or payments for recovered urban ecosystem services.

**How to restore the last wetland of Mexico City?**

**Zambrano, Luis; Elsa Valiente, Armando Tovar**

Universidad Nacional Autónoma de México

Mexico City was founded in a valley with five wetlands, only one survives today from being dried out: Xochimilco. Since the Aztecs, Xochimilco has been managed for agriculture practices in chinampas (islands built using wetland sediments). These practices increased habitat for aquatic endemic species. But urban pressure over this wetland has dramatically increased in the last century. Consequently, the water quality is reduced, and there are several introduced species such as lilies, carp and tilapia. At least five native species have gone to extinction and others transit through the same path, such as the endemic axolotl *A. mexicanum*. The abandonment of agricultural practices opens the land for urban speculation. Attempts to restore Xochimilco based on a rapid economical development, such as Caribbean manatee and herbivorous carp introductions, have increased the ecological and agricultural deterioration in the wetland. We propose to restore the wetland as the habitat of the aquatic native species at the same time of re-vitalizing traditional agriculture practices by generating axolotl refuges in canals that surround chinampas. Canals have local-made filters, which leave exotics out from the refuges and help to increase water quality within the refuges. This is increasing native species growth. Water from canals can be used for agricultural products with better quality and can be sold with an “Environmental Friendly” seal within Mexico City market. Local farmers participation is crucial as well as monitoring assessment of water quality and native species population.

**Comportamiento temporal y espacial de la Productividad Primaria Neta Aérea (PPNA) y composición florística de pasturas naturales asociadas a tres especies de árboles dispersos en Nicaragua**

**Zapata Arango, Piedad Cecilia; Muhammad Ibrahim, Graciela Rusch, Fabrice De Clerk, Pere Casals, Fernando Casonoves**

Cipav, Colombia

Se evaluó el efecto de árboles de carao (*Cassia grandis*), roble (*Tabebuia rosea*) y guáímico (*Guazuma ulmifolia*) sobre la productividad primaria neta aérea (PPNA) y composición florística de pasturas naturales de Nicaragua. Los resultados indican que los bajos niveles de precipitación y el pastoreo continuo durante el periodo seco parecen afectar negativamente la presencia de ciertos grupos de plantas en la pastura, lo cual se reflejó en un mayor porcentaje de suelo desnudo y disminución de la PPNA durante abril (mes seco). Además, la riqueza, diversidad y productividad de los pastizales fue mayor durante los meses lluviosos (Mayo, Junio y Julio) que en abril y bajo los árboles que en la pastura abierta (*P < 0.05*). La variación en el régimen de lluvias desencadenó un efecto sobre el comportamiento foliar de las tres especies de árboles, registrándose una mayor densidad de copa en carao en julio, mientras que la menor densidad de copa se registró en árboles de guáímico y roble en abril. La especie más abundante en los pastizales fue *Paspalum notatum* pero su presencia disminuyó significativamente bajo árboles de carao frente a árboles de roble y guáímico lo cual estaría relacionado con una menor tolerancia a la sombra debido a su condición de especie C4. Finalmente, la mayor presencia de *Panicum laxum* bajo los árboles frente a la pastura abierta demuestra su tolerancia a la sombra relacionada con su metabolismo fotosintético C3.
Reconstrucción geomorfológica y restauración ecológica de la cantera de Somolinos (Guadalajara, España)

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Las restauraciones mineras basadas en los modelos “convencionales” (berma-talud), se demuestran con frecuencia ineficaces en ambientes mediterráneos. Esto se debe a que son muy inestables frente a la erosión hídrica y ocasionan graves efectos tanto en el interior de las minas (on-site effects) como aguas debajo de éstas (off-site effects). Incorporar principios geomorfológicos en la restauración ecológica de estos espacios, se presenta como una herramienta eficaz para solucionar muchos de los efectos ambientales que genera la minería de superficie, así como para restaurar el capital natural de los terrenos afectados por esta actividad. Los diseños geomorfológicos más avanzados a nivel mundial en este tipo de terrenos se basan en laderas convexo-cónicas, con redes de drenaje. Toda la superficie se dimensiona teniendo en cuenta un referente próximo a la zona, las condiciones climáticas del entorno y la cantidad de estériles disponibles en la cantera a restaurar. El objetivo final es restaurar procesos hidrológicos y geomorfológicos modificados por la actividad extractiva, y recuperar los bienes y servicios ambientales. En el primer semestre de 2011 se ha ejecutado en España el primer diseño de restauración ecológica con criterios geomorfológicos que ha seguido el método (GeoFluvTM) y su software (Natural Regrade). Se trata de una cantera de arenas en Somolinos (Guadalajara, España) que fue restaurada en 2005, pero que no solucionó los problemas de erosión que limitaban el desarrollo del suelo y la vegetación. También producía altas emisiones de agua y sedimentos en los cauces naturales circundantes. Esta comunicación describe los detalles de este proceso.

Study on the status and countermeasures of mine ecological restoration in China

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In recent years, mineral resources have been mined intensively in China, which causes ecological damage and environmental pollution. Surface mining results in an excavation pit, land occupation, land damage, the landscape changes with the surface, destruction of vegetation, heavy soil erosion, damage and changes in wildlife habitats, and threats to biodiversity. Underground mining results in damage to groundwater systems, ground collapse or landslides, mudslides and other secondary geological disasters. The atmosphere, water environment, soil, noise, and solid waste pollution are serious. Mineral mining is one of the sources of environmental pollution, and has become a major source of problems arising in promoting economic growth, and to a certain extent restricts sustainable economic and social development. Ecological rehabilitation and management of mining sites are very difficult tasks. In this presentation the techniques and achievements for ecological restoration in mined areas will be discussed. Subsidence, topsoil dump, waste dump, tailings and other mining sites are summarized on the basis of investigation in large number of typical cases of ecological restoration of mines in China. The major ecological restoration projects and technical means are the stripping and stockpiling of topsoil, erosion control, plant species selection and restoration of vegetation, rehabilitation of subsidence, safety protection, and restoration of contaminated sites. The problems and the countermeasures of environmental management, policy systems, technical and economic conditions and others were studied and analyzed.

Land planning as a means to rehabilitate and preserve natural remnants in Luján County, Buenos Aires, Argentina

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In most of the administrative areas that make up the third metropolitan belt of Buenos Aires megacity, the increasing human intervention through urban sprawl represents a major threat to the integrity of natural remnants due to connectivity reduction and habitat degradation. Most habitats are becoming at risk and conservation/restoration measures are urgently needed. The aim of this study was to contribute to balance human development with environmental protection by generating alternative land use scenarios for decision makers and related stakeholders. By visual interpretation of Landsat satellite imagery, field validation, interdisciplinary data gathering, and GIS analyses, three type of maps were generated: environmental sensitivity, sustainable use expected, and land use zoning (proposals). Sensitivity was calculated as a function of intrinsic (natural) attributes of current conditions as well as the impacts of current land uses. Expected sustainability maps were estimated by reclassification of
sensitivity maps and according to both historical and projected human needs, but considering current technological development. Future land uses were determined for the whole Luján County giving priority to restoration and/or conservation areas. As a result of these analyses, we proposed that 14% (10,771 ha) of the county should be designated as Natural Protected Areas and included in the National Parks System; specific sites for ecological restoration were identified within these areas. On the other hand, 49% (37,692 ha) of the Luján land is compatible with a extensive livestock production (sustainable use), and the remaining 38% (29,250 ha) with a sustainable agricultural use. Two alternative development scenarios are discussed and a model of land planning over time is proposed.

Out of this worldview: When aliens invade our experience of nature

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This paper explores the role of meaningful nature experiences (MNEs) in social-ecological restoration and education. MNEs (e.g. peak and awakening experiences, profound and synchronistic encounters with wildlife) appear to link nature and culture across geography and traditions. They are often associated with emotionally-charged encounters in relatively pristine or wild settings. Introspective time spent in such environments is central to many indigenous cultures and a tenet common to founders of the world’s major religions. These times serve as a rites-of-passage and are said to awaken an individual’s sense of belonging and ‘soul purpose’. Such encounters are now relatively rare in Western culture though people do still report meaningful experiences in various contexts. Their effects may instigate an individual’s process of reconnecting with nature. Our ability to access these transformative experiences may be under threat. In particular, the impact and influence of invasive alien species (IAS) on MNEs is largely unstudied. We employ mixed methods research utilizing Likert-scale questionnaires, semi-structured interviews and phenomenological analysis. With a focus on Acacia mearnsii in South Africa, our results largely confirm negative implications. However, we also find that emotive feelings of oneness and kinship invoked during MNEs may displace rational knowledge of IAS being ‘bad’ or out of place. Metaphorical parallels are also drawn with a globalised human society. Given education’s influential role in shaping perception, the restoration community must critically reflect on the question, “How to educate?”

POSTER ABSTRACTS

(The affiliations listed are those of the presenter only)

Ecological restoration within the Lower Pitt River, British Columbia, Canada

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The impetus for ecological restoration within the lower Pitt River of British Columbia was the regulatory requirement to create fish habitat to offset the loss of drainage ditches associated with urban development. Rather than create fragments of fish habitat within an otherwise developed landscape, the project design pursues the restoration of ecosystem functions by linking created features with existing natural features of the lower Pitt River ecosystem. Fish habitat is created as a result of the larger effort to restore ecosystem functions. The design location for ecological restoration was behind a dyke; original soils and topography had been retained. A contemporary site outside of the dyke, within natural floodplain influenced by both tidal and fluvial processes, with similar soils and topography, was utilized as the model for design. Based on this model, the dyke was relocated inland. Morphological features characteristic of the habitat model were constructed. Assemblages of plant species representative of assemblages that occur at the contemporary site were planted. The product is a 6.5 hectare floodplain complex representative of floodplain features once associated with the project location. This ecosystem-approach to ecological restoration challenges the mainstream approach to restoration, whereby fragmented landscape features are created to address very specific impacts attributable to isolated development activities. It serves not only to meet antiquated habitat compensation objectives, but also to restore larger ecosystem functions through integration of natural function and connectivity of habitats.
Evaluation of the valuation of the survival of native species used in degraded areas in the Brazilian Savanna

CRAD, Universidade de Brasilia

Brazilian Savanna is the second largest biome of Brazil, which consists of a mosaic of vegetation physiognomies (savannas, forests and grassland) and has been identified as one of the world’s biodiversity hotspots. The acceleration of the degradation is mainly due to the expansion of the agricultural frontier, so it is necessary to adopt new management techniques, for the conservation and restoration of these ecosystems. The objective of this study was to analyze the survival rates of a plantation of selected species from the Demonstration Models of Recuperation - DMR in a gravel pit area in the São Francisco river basin in the state of Minas Gerais, Brazil. The DMR uses a mixed plantation with native species from the different vegetation types, where the fast growth of forest species and the greater adaptability to biotic and abiotic conditions of savanna species, improve the soil recovery. 41 species (1,852 seedlings) were used: eighteen from cerrado sensu stricto, seven from the gallery forests and sixteen from seasonal forest. The overall survival rate 24 months after planting was 92%. Seasonal forest species had the best establishment in the degraded area showing a survival rate of 97%, which was statistically significant, compared to the others two groups (89%). From the 27 species that showed a survival rate between 90% and 100%, eight belong to the cerrado sensu stricto, four to gallery forest and fifteen to seasonal forest, which helps to indicate the most appropriate species to use in recuperation projects of degraded lands in cerrado.

Assessment of the governmental program of payment for hydrological environmental services in the National Park Nevada de Toluca, Mexico

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Degradation of forest resources, deforestation and water overexploitation are some of the main environmental problems caused by population growth, of concern for the current study in the National Park Nevada de Toluca. Actions to tackle these problems have not waited, nor the governmental programmes implemented. However, due to the potential negative impacts of these environmental issues, it is significant to assess such programmes in order to increase their effectiveness; qualitative methodologies allow assessing them. In order to evaluate the programme of Payment for Hydrological Environmental Services of the Government of the State of Mexico, in Mexico, field work, interviews to key informants, and residents’ surveys were carried out. Qualitative and quantitative characteristics are included in the analyses and it assesses the programme’s results throughout feasibility assessment by applying multicriteria evaluation. The evaluation considered external criteria such as visitors’ activity in the park and governmental policies, and internal criteria such as local communities’ activities, their conservation practices and their valuation of natural resources. An inefficient implementation of the programme generates unexpected results due to lack of knowledge of local communities and/or to lack of interest of governmental authorities. A restructuring of the programme and/or its implementation mechanisms is recommended; it should consider an efficient advertising programme, and the inclusion of local knowledge, traditional farming and conservation practices, and sustainable agroforestry practices.

Plant ecological studies underpinning phytoremediation approaches for oil-damaged desert environments in Kuwait

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During the First Gulf War (1990-91), major hydrocarbon pollution of desert soils occurred in Kuwait as a result of damage to, and burning, of some 700 oil-wells. We report results from a survey of oil-damaged ecosystems in Kuwait, aimed at establishing the phytoremediator potential of native plant species, which establishes the range and abundance of plant communities characterized by Haloxylon salicornicum, or Cyperus conglomeratus (considered from previous studies to be tolerant of hydrocarbon-polluted soil conditions), plus other plant communities, across gradients of oil pollution stress, and other anthropogenic disturbances. The data were analysed using TWINSPLAN to classify 200 vegetation samples, from 7 areas of Kuwait, into 8 sample-groups in relation to soil Polycyclic Aromatic Hydrocarbon (PAH) content, plus additional relevant environmental variables, in order to establish the relative abilities of potential phytoremediator plant species, and assemblages, to survive and grow in oil-damaged desert soils in Kuwait. ANOVA testing between variables measured for these 8 sample-groups reveals significantly greater
Favorecer la interacción de las especies con diferentes funciones ecológicas aumenta la certidumbre del éxito de la restauración, creando condiciones que catalizan la recuperación de los ecosistemas. Así, la aplicación de la teoría de nucleación acelera la resiliencia de los ecosistemas al atraer mayor diversidad hacia el área degradada. Es indispensable comprender los procesos ecológicos involucrados en la historia de vida de las especies para garantizar el éxito de la nucleación. En este estudio evaluó las características y la germinación de cinco especies (Melastomataceae), con potencial para atraer los animales y funcionar como núcleos. Este estudio se llevó a cabo (agosto/10-abril/11) en una zona de regeneración natural, Brasil. Las semillas de cinco plantas fueron recogidas y lavadas en NaClO(4%) y, en menos de tres días, los experimentos de germinación fueron instalados. La germinación se realizó en germinador (25°C) con dos tratamientos (luz y oscuridad) y cuatro repeticiones de 50 semillas (n=200), evaluadas diariamente, durante 60 días o hasta la protrusión radicular. Sólo Tibouchina stenocarpa (DC) Cogn.(12%) y Miconia chamissonis Naud. (2,5%) germinaron en la oscuridad. En la luz, las especies arbustivas ornitológicas: Tococa formicaria Mart.(81%), M. chamissonis (60%), Miconia albicans (Sw) Triana (46%) y Miconia ibaguensis (Bonpl.) Triana (31%) alcanzaron su máxima germinación en la 2ª semana, mientras que el árbol anemocórico T. stenocarpa (77%), en la 1ª semana. Estas especies son claves para la nucleación porque tienen muchas semillas, buena germinación, crecimiento rápido y polen y frutos durante todo el año, características esenciales para acelerar la restauración ecológica.

Reservas privadas del patrimonio natural como áreas prioritarias para la conservación de Brachyteles arachnoides en el Estado del Río de Janeiro – Brasil
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Instituto Estadual do Ambiente do Río de Janeiro

La pérdida de hábitat y la fragmentación forestal son amenazas para la conservación de la diversidad biológica en la Foresta Atlántica, Brachyteles arachnoides, es una especie nativa del sureste de Brasil en peligro de extinción. Las Reservas Privadas del Patrimonio Natural (RPPN) reconocido por el Instituto Ambiental del Estado del Río de Janeiro (INEA), pueden ser una alternativa para la conservación de la especie. Este estudio tuvo como objetivo examinar el potencial de 44 RPPN con el propósito de desarrollar actividades de conservación para mantener las poblaciones del mono araña, que necesitan una área de vida de 300 hectáreas. Las RPPN fueron delineadas sobre imágenes de satélite utilizando el software ArcGIS. Fue analizada la superficie forestal (hectárea) de cada RPPN y su entorno inmediato, así como la conectividad con otras Unidades de Conservación (UC). De las RPPN analizadas, 55% están cubiertas por bosque continuo > 300 hectáreas. De estas, 83% están conectadas a fragmentos > 5000 hectáreas y 45% están menos de 200 m de distancia de otras UC. Llega a la conclusión de que estas áreas son prioritarias para o desarrollo de actividades de conservación de B. aracnoides y toda la biodiversidad asociada. En las RPPN y bosque que la rodea con cubertura < 300 hectáreas, está recomendado un programa de restauración de las Áreas de Preservación Permanente para promover el estabecimiento de corredores ecológicos.

Mimosa monancistra para fitorremediación de suelos con HPA’s
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La fitorremediación es una tecnología de bajo costo para descontaminar suelos con hidrocarbonos policíclicos aromáticos (HPA). Se realizó un experimento en invernadero para determinar el crecimiento de Mimosa monancistra una leguminosa fijadora de nitrógeno y su capacidad para disipar fenantreno, antraceno y benzo(a)pireno (BaP) de suelo. Los HPA disminuyeron el crecimiento de raíces y parte área de la planta 2.7 y 3.9 veces respectivamente en comparación con las plantas cultivadas en suelo sin contaminar e inhibieron la formación de nódulos. La remoción de fenantreno y antraceno fue igual en el suelo con la planta y sin planta, sin embargo la disipación de BaP fue
significativamente más rápida en suelo con planta comparada al suelo sin planta después de 14, 56, 70 y 90 días. Después de 90 días la disipación de BaP fue del 96% en suelo con la planta y del 87% del suelo sin planta. La nitrificación y amonificación no se vio afectada por la adición de HPA, así como las concentraciones de NH4+, NO2- y NO3- fueron similares en el suelo contaminado y sin contaminar con planta. El crecimiento de M. monancistra fue inhibido por la contaminación con hidrocarburos, pero hubo una remoción acelerada en su rizosfera de BaP.

**Efecto de la adición de vermicomposta en la nitrificación y mineralización de carbono en un suelo con plaguicidas**

**Álvarez Bernal**, Dioselina; Rebeca Flores Magallón, Verónica Sosa Torres, Erica Y. Talavera Díaz  
CIDIR-IPN Unidad Michoacán

El uso indiscriminado e incesante de agroquímicos, cambia las poblaciones microbianas y/o la actividad de algunas especies de microorganismos, también tiende a cambiar las características físicas y químicas de los suelos provocando suelos erosionados y pobres en materia orgánica. Se ha observado que la aplicación de materia orgánica tiene un efecto complejo en la degradación de plaguicidas (bioestimulación). Se realizó un experimento de 28 días para determinar el efecto de vermicomposta en la nitrificación (NH4+, NO2- y NO3-) y mineralización de carbono (CO2) de suelos que tienen un historial de uso de plaguicidas, se observó que las concentraciones de NO3- y CO2 en el suelo contaminado con plaguicidas fueron menores que en el suelo control y 1.5 veces más grandes en el suelo adicionado con vermicomposta, la textura de estos suelos contaminados es arenosa. Los suelos contaminados con plaguicidas son suelos con bajo rendimiento en cuanto a la nitrificación y mineralización y afectados en las propiedades físicas y químicas.

**Dinámicas de carbono y nitrógeno en suelos de bosques tropicales estacionalmente secos con diferente gradiente pluvial**

**Álvarez Bernal**, Dioselina; Luc Dendooven, Julio Campo  
CIDIR-IPN Unidad Michoacán

Los bosques tropicales estacionalmente secos (BTES) se caracterizan por sufrir sequía por periodos largos de tiempo, México se identifica por tener el 8% de este tipo de bosques; la estacionalidad es un factor crítico en el clima y la vegetación así como en la circulación de carbono y nitrógeno, en la Península de Yucatán sólo el 2% tiene una cubierta original de este tipo de bosques debido al cambio de uso de suelo. Se llevó a cabo una dinámica de carbono (mineralización de carbono CO2) y nitrógeno (amonio, nitritos y nitratos) en tres suelos (Hobonil, Mérida y Chihxchulub) con diferentes condiciones pluviales para valorar si esta condición afecta la nitrificación y mineralización de carbono. La concentración de NO3- fue alta, lo cual significa que se llevó a cabo la nitrificación en los tres suelos, quedando las concentraciones Hobonil<Mérida.

**Economic restored forests for traditional communities**

**Amazonas**, Nino; Aurélio Padovezi, Ricardo Viani, Rubens Benini, Luiz de Lima  
The Nature Conservancy

In many situations, forest restoration may not be economically attractive to landowners because, besides being expensive, it may reduce agricultural area. This is especially valid when talking about low income traditional communities living in rural areas of large natural vegetation cover. The Nature Conservancy is working together with governmental, environmental, and research agencies and other NGO’s on the construction of restoration models that allow future economic returns in the medium and in the long run. Restoration models are being built together with local communities, who will also be trained to restore areas either by assisted natural regeneration and/or planting trees, including all stages of restoration projects. This participative method for building restoration models values the native flora and the knowledge traditional communities accumulated over generations, and ally all this with demands for forest derived products. We identified one main species with economic potential per location. For areas in São Paulo, *Euterpe edulis* Mart. was the main species chosen for future sustainable exploitation. In Paraná, *Ilex paraguariensis* A. St.-Hil.was pointed out by the community as the most important species. An interesting fact is that both species grow well in the understory and represent an important opportunity for the maintenance of upper story forest cover. Having people involved in restoration activities and future management for sustainable use, together with the economic returns from forest products, is crucial for the success and leverage of restoration in the Brazilian Atlantic Forest, and also for it to be economically more attractive.
Evalúación del efecto de la tecnología del pasto Vetiver (TPV) en la restauración ecológica de la autopista Gran Mariscal de Ayacucho, Venezuela

Andara García, Juan Antonio; Germán Trujillo, Evangelina Arcaña
Biotecnica C.A.

La tecnología del pasto Vetiver (TPV) consiste en el uso de barreras vivas de vetiver (*Chrysopogon zizanioides*) para la conservación del ambiente. BIOTECNICA es una empresa de servicios ambientales, que empleó esta tecnología en el año 2006, para la restauración de áreas de bosque siempre verde, que fueron degradados por la construcción de la Autopista Gran Mariscal de Ayacucho, tramo Caucagua-Higuereote, en el Municipio Brión, Estado Miranda, Venezuela. La tecnología aplicada consistió en el establecimiento de 25.000 m de barreras vivas de vetiver en puntos críticos de la autotropa. Tales barreras se ubicaron siguiendo las curvas de nivel, con distancias entre plantas de 15 cm y entre hileras de 50 cm. En el momento del trasplante se aplicó hidrogel (Poliacrilamida) y fertilización con fosfato diamónico ((NH4)2HPO4). Durante los primeros quince días se efectuaron riegos, control manual de malezas y un reabono con urea. Con el objetivo de evaluar el impacto ecológico del TPV, se realizó un levantamiento de la situación actual de diversas variables relacionadas, verificándose, no solo la conservación de la obra donde se utilizó TPV, sino también evidencias de procesos de sucesión ecológica con tendencia a la recuperación del bosque, apreciándose que este proceso se vio favorecido por los efectos mejoradores del vetiver sobre las condiciones sucesionales.

Changes in tree species composition, abundance, and diversity in a remnant historic prairie grove in central Illinois, USA over a twenty-eight year period

Anderson, Roger
Illinois State University

In the past century, as a result of fire suppression associated with European settlement, Midwestern USA woodlands on mesic upland sites transitioned from dominance by fire resistant, shade-intolerant oak and hickory species to dominance by shade-tolerant, but fire sensitive mesophytes, such as sugar maple. I studied changes in tree species composition and diversity in one of these upland forests, Thaddeus Stubblefield Grove, over 28 years (1977-2005). The 13 ha study site has been protected since 1833 and currently supports a closed canopy forest dominated by sugar maple (*Acer saccharum*). However, when this study was initiated, scattered large (120-180 cm dbh) living and dead open-grown burr oaks (*Quercus macrocarpon*) provided evidence of a more open historic forest. According to Government Land Office records (1820), oaks dominated the historic vegetation with a combined Importance Value (IV) of 43.2; IV for all species sums to 100. Historic tree density was 28 trees/ha compared to current densities of 275 trees/ha. American elm (*Ulmus americana*) (IV = 29) was the leading species in the 1977 sample. However, by 1984 Dutch elm disease had caused a rapid decline in American elm (IV = 1.6) and sugar maple (IV = 46) replaced it as the dominant species. In the past 10-15 years, browsing by white-tailed deer has diminished seedlings of most tree species, except for paw paw (*Asimina triloba*), an unbrowsed species, which has increased in abundance. Current forest conditions and cultural and economic factors appear to preclude restoration of the site to historic conditions.

Effect of removal of second-year garlic mustard (*Alliaria petiolata*) on first-year plants and deciduous forest spring and summer dominant herbaceous groundlayer species in central Illinois, USA

Anderson, Roger; Jamie Herold, M. Rebecca Anderson, Jonathan T. Bauer, Victoria Borowicz
Illinois State University

Garlic mustard, a biennial Eurasian species, has extensively invaded eastern North American deciduous forests. We studied effects of three years (2005-2007) of annual removal of second-year garlic mustard plants on first-year plants and native spring herbaceous species in upland and lowland woods. Treatments compared removal of second-year plants in mid-March (Early Treatment) or mid-May (Late Treatment) to a control. First- and second-year plants and native herbaceous species percent cover were recorded on April 19 and 20. First-year plant cover was higher on Control than Treatment plots; however, in the Upland Woods only Control and Late Treatment differed significantly. First-year plant cover was less in removal than Control plots, indicating reduced seed input; however, we found no difference in second-year plant cover between Late Treatment and Control plots. Results suggest second-year plants strongly compete with younger conspecifics and their removal decreases first-year plant mortality. Second-year garlic mustard removal did not significantly affect total cover of native herbaceous species. Second-year plants complete vegetative growth before late May, and might impact early growing species more than late developing.
native species. We tested effect of removal of garlic mustard on spring and summer dominant native species. We found no Treatment effects on summer dominant species. However, Early Treatment plots had significantly more cover of spring dominant plants than Late Treatment and Control in the Upland Woods.

**Reproductive success in American ginseng is influenced by population genetic diversity**

*Anderson, M. Rebecca; Sabine S. Loew*  
Illinois State University

American ginseng is a commercially valuable but uncommon understory plant of forested regions in eastern USA. We studied 12 populations of varying size in Illinois, Wisconsin and Missouri for reproductive output, plant size, population size and genetic diversity. We predicted that reproduction would be positively affected by population size and genetic diversity. In addition larger plants reproduce more. Plant size was assessed by a synthetic variable using Non-metric multidimensional scaling (NMS, 6 variables). Multivariate analysis of reproduction of 3-leaf plants was tested against population identity with plant size (NMS score) as covariate. Non-significant differences among populations indicated that differences in reproduction of flowers, fruits and seeds among populations were the result of differences in plant size in populations, even within size class. Two populations produced significantly more fruits and seeds per unit mass than others. We tested reproductive success per unit mass against genetic diversity measures using amplified fragment length polymorphisms (AFLP) generated by 3 primer pairs. Reproductive output (fruits or seeds per mass) was not well-explained by population size. Genetic diversity analysis showed that percent polymorphic sites (population averages) ranged from 36.25 – 56.25. Average gene diversity over loci ranged from 0.113 – 0.209. Overall F(ST) for 14 populations was 0.055, indicating little divergence in populations. Population F(ST) values ranged from 0.026 – 0.081. Flowers, fruits and seeds per unit mass (NMS unit) were greater in populations with greater % polymorphic loci, higher gene diversity and lower F(ST). The two most productive populations differed significantly from others, and had greatest genetic diversity.

**Is reforestation a paradigm in restoration programs?**

*Andrade, José Luis; Isaac Castillo-Cruz, Robert Santamaría, J. Luis Simá, Jorge Herrera-Silveira*  
Centro de Investigación Científica de Yucatán

Reforestation campaigns are usually intended to accelerate restoration. However, for most plant species, individual survival is minimal when adequate measures for assuring plant growth in harsh microenvironments are not attended. Nurseries grow plants from seeds or cuttings in favorable conditions, which are almost never the conditions that plants will find when transported to the sites under restoration. Some physiological plant ecology knowledge is needed to understand this fact. Our approach will be explained taking into account four fundamental processes: water balance, energy balance, respiration and photosynthesis. Conduits for water transport are dead cells and once formed, they will not reconstruct again. Vessels are broader in plants grown in well water conditions than in those grown in dry soils. So, they would not modify easily for the plants to survive the new conditions. Similarly, leaf anatomy, morphology, physiology and biochemistry changes take time to permit plant survival. We will present some data on mangrove plants that were planted versus those that grew spontaneously by a restoration plan, which allowed entrance of seeds and other dispersal structures.

**Baja riqueza específica de leptisminos registrada en Centroamérica**

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Universidad Nacional de Tucumán

La biodiversidad, considerando la complejidad de hábitats y ocupación de nichos, se espera que disminuya desde Centroamérica hacia regiones subtropicales. Este estudio compara ambas regiones. Se cotejaron citas bibliográficas, con resultados de recolecciones del norte argentino donde se trabaja durante más de 20 años. De los Leptysminae descritos (más de 90 taxones), América central suma 11 especies: Stenopola dorsalis (Th.), Stenopola p. limbipennis Stål, Cornops aquaticum Bruner, Tucayaca caeruleipes Roberts, Stenacris vitriepennis (Marsch.), Stenacris minor (Bruner), Stenacris xanthochlora (Marsch.), Stenacris fissicauda goethalsi(Hebard), Leptysma marginicollis mexicana (Saussure), Cylindrotettix insularis herbaceus Bruner y Guetaresia lankesteri Rehn. Muchos taxones muestran distribución discontinua, no existen registros en Nicaragua; para El Salvador son mínimos (1 sp); siendo Costa Rica y Panamá los países de mayor riqueza (7 spp). En el norte argentino fueron citadas 20 especies y subspecies. Tucumán, la provincia más pequeña, registra 15 y Belice con una superficie equivalente, 4. Se atribuye el gran sesgo y vacío existente a escasas recolecciones sistemáticas; hábitats de difícil acceso, humedales o arboreos de encuentro al azar. Intensificando la búsqueda es probable registrar un considerable número de especies. En
conservación se resta valor a los sistemas poco diversos y para conservar se debe conocer fisonómica y funcionalmente lo que se conserva.

**Lessons from a century of restoration in Iceland**

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Agricultural University of Iceland

Since Iceland was settled in the ninth century, Icelandic ecosystems have been altered by severe ecosystem degradation and soil erosion. Initial efforts of restoration at the beginning of the twentieth century were driven by a concern about the loss of woodlands and frequent wind erosion events in lowland areas posing a risk to extensive farming communities. Later the main emphasis was on reclaiming barren land to use for grazing or hay production, by seeding grasses and fertilization. Restoration as a mitigation of vegetated land submerged by dams, damaged by road construction or by gravel mines, started in the 1970s. In the past two decades there has been increased emphasis on restoration of important native habitats, such as birch woodlands and wetlands. Also, carbon sequestration for mitigation of climate change is increasingly becoming one of the drivers for restoration work. A recent review of restoration in Iceland describes 85 projects extending over more than 1700 km². More than 1500 km² thereof involve revegetation or reclamation of eroded or severely degraded land. Although ecological restoration was not the immediate goal of many of these actions, research has shown that they have triggered succession trajectories towards functional native grasslands, heathlands or woodlands. A century of restoration in Iceland demonstrates that while the reasons for restoration actions have changed over time, their long term effects are the return of ecosystem functions and natural capital of severely degraded land.

**Propuesta para aumentar la vegetación leñosa y mejorar el suelo en minifundios de Piribebuy, Paraguay**

*Aranda Espinoza, María Lidia; José María Rey Benayas*

Universidad Nacional de Asunción

Este trabajo propone un proyecto de aumento de la cobertura vegetal leñosa y mejora del suelo en minifundios de Piribebuy, Paraguay, para incrementar los servicios ecosistémicos en el lugar de forma compatible con la producción agrícola. En Paraguay la agricultura es la actividad principal del medio rural, siendo la agricultura minifundista (menos de 10 Ha) la más extendida. La actividad agrícola es también un factor de degradación de los ecosistemas y es difícil la integración del uso productivo con la conservación y la restauración. Para ello se ha caracterizado, en primer lugar, el escenario de partida en los componentes paisaje, vegetación y suelo, con el fin de conocer la realidad local y establecer propuestas apropiadas. Las propuestas de restauración implican actuaciones de revegetación y de involucramiento social. Entre las primeras destacan la revegetación de 5000 metros bordes de camino, 3200 metros de lindes agrícolas e implementación de 50 hectáreas de sistemas agroforestales. Estas actuaciones combinan especies leñosas nativas con cultivos agrícolas tradicionales para aumentar la biodiversidad, mejorar el suelo, crear espacios de hábitat para la fauna y fomentar pequeñas áreas de conectividad de paisaje. Para las segundas se proponen actuaciones que integran a las familias rurales en la restauración local para alcanzar un nivel de gestión compartida en el proyecto y así favorecer la permanencia en el tiempo de las diferentes actuaciones.

**Restoration needs of riparian habitats in a regional and social ecotone: Iberá wetlands (public) – Campos and Malezales (private)**

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Universidad Maimónides

Both Iberá and “Campos y Malezales” eco-regions still harbour a representative landscape structure of natural ecosystems, although they are ruled by public (Provincial Protected Area) and private (productive) sectors, respectively. As such, most efforts are devoted to establish biodiversity conservation measures. However at the local-intermediate scale, ecological restoration needs are emerging due to unsustainable practices (overgrazing, unprescribed burning, heavy agro-industry) under specific situations. This study aims to develop a restoration plan for a highly sensitive habitat: riparian grasslands associated with *Butia paraguayensis*, a fast-declining palm species due to habitat loss and degradation. Plant community attributes (diversity, cover of functional groups) were quantified (Canfield line-interception method) in ten sites along 15 km of riparian shoreline in Northern Iberá, closed to Yacyretá dam (Corrientes, Argentina). Principal Component Analyses (PCA) showed that 64% of the variation can be explained through one component, negatively related to grass cover and positively associated to six ecological attributes: plant diversity (H’ Shannon-Wiener index), richness (S), and cover of B. paraguayensis, trees, shrubs, and
forbs. PCA ranked sites from highly degraded (absence of all tree species including B. paraguayensis; H²=1.20; S=15; grass cover >90%) to climax-near condition (B. paraguayensis cover 14-16%; tree cover 16-22%; H²=2.94; S=60; grass cover <60%). These results encouraged private landowners to establish a restoration program involving a nursery for native species (started in 2010), prescribed burnings, grazing reduction and grassland enclosures for long-term monitoring and comparison purposes.

**Initial results from a Michigan sand prairie restoration experiment: Nature or nurture?**

_Aschenbach, Todd; Robb Roos, Carolyn Henne_

Grand Valley State University

Sand prairie in Michigan, USA was a primary component of the state’s historical oak-pine barrens ecosystem. However, sand prairie has been all but eliminated in the state and few attempts at restoring this ecosystem have been conducted. Our sand prairie restoration experiment, established in 2009 in the Manistee National Forest, seeks to develop a successful approach to restoring this ecosystem. Specifically, we examine the influence of variable seeding rates of native plant functional groups (graminoids, early season forbs, late season forbs, legumes) on plant community restoration success. Here we present data from 2011 that examines the impact of seeding on community variables since the initiation of the experiment and determine if seeded plots exhibit significant changes over and above changes expected in non-seeded (control) plots. Here we differentiate between changes due to succession (i.e. “nature”) from changes due to our restoration efforts (i.e. “nurture”).

**Revegetación de cárcavas en suelos charcosos con tres especies de leguminosas en Atécuaro,**

_Michoacán, México_

_Aureoles Celso, Esteban; Mariela Gómez Romero, Roberto A. Lindig Cisneros_

Universidad Michoacana de San Nicolás de Hidalgo

El sitio presenta graves problemas de erosión como consecuencia de deforestación, agricultura y ganadería, como consecuencia, existen suelos desprovistos de vegetación, que con el paso del tiempo, fueron perdiendo suelo por efecto de lluvia y viento, formando así gran cantidad de cárcavas. Se propuso estudiar el establecimiento por semilla y planta de tres especies de leguminosa (Lupinus elegans, Crotalatia pumila y Trifolium repens) para conocer el establecimiento y contribución con la formación de sotobosque, ya que juega un papel importante para el establecimiento futuro de árboles. Se trazaron 21 parcelas de 9 m², 4 en pendientes planas (0°), 4 en pendiente medias (7.76°), 4 en pendiente alta (27.13°) y 9 distribuidas en toda la cárcava. En pendiente plana y media se sembró combinación de semillas de las 3 especies (L. elegans 8.4gr, C. pumila 6.4, y T. repens 24) y se plantaron 8 de las 2 primeras. En 4 parcelas de pendiente alta, sólo se utilizaron plantas propagadas. En las 9 parcelas adicionales (3 por especie) se realizó el sembrado. Las semillas fueron escarificadas previamente. L. elegans en parcelas de pendiente media presentó mayor supervivencia con altura de 75cm, así como mayor germinación (39%). C. pumila, alcanzó alturas mayores en pendientes altas con 58cm, y en las pendientes plana y media presentaron altura de 50cm. La mayor germinación se presentó en sitios planos (5%), T. repens 3%. El establecimiento de plantas en suelo desnudo, contribuye a minimizar la acción del viento y dispersa gotas de lluvias, reduciendo la fuerza erosiva.

**El biochar producido de residuos de jardinería como alternativa de captura de CO2 atmosférico en suelos**

_Bacre González, Ramón Agustín; Pilar Ortega, Cristina Siebe, Sergio Palacios, Javier Montoya_

_Instituto de Geología, UNAM_

Se ha descrito al producto de la pirólisis de material orgánico o biochar, como una sustancia rica en carbono orgánico recalcitrante (COR) y como una alternativa importante para el secuestro de carbono en suelos. En el campus de Ciudad Universitaria de la UNAM se manejan aproximadamente 1500 t/año de residuos de sus jardines que son llevados a la planta de composteo de la universidad. De éste material orgánico se desconocen tanto la proporción de COR en forma de composta, como la cantidad de carbono orgánico mineralizado a la atmósfera en forma de CO. El objetivo del trabajo fue conocer el rendimiento de COR en forma de biochar que es producido al final del proceso y evaluarlo como alternativa de manejo de residuos de jardín. Se utilizó un sistema cilíndrico de pirólisis de baja temperatura, con capacidad de 12 Kg/lote y rango de temperatura de operación de 250-400°C, durante 180 min. De acuerdo a lo reportado, el rendimiento del biochar producido 4.9 kg, en relación al material de origen fue alto, 40% y su contenido de carbono orgánico estuvo dentro del rango reportado, 50-52%. Éste análisis permite asegurar que los residuos de jardín tienen un rendimiento alto en la producción de biochar y pueden ser una fuente importante de COR para capturar CO₂ atmosférico en suelos urbanos, periurbanos y rurales.
Reproduction of orchid taxa in a restored neotropical forest

Bare, Matthew
Jardín Botánico las Orquídeas

Approximately 300 species of orchids were transplanted into a six hectare restored neotropical forest from 1980 to 2000. A one-year survey of the orchids was conducted to determine seeding frequency and seedling recruitment. Orchids were surveyed every six weeks for seed set, and the areas of seeding orchids were also surveyed for seedling recruitment. Results will indicate species that repeatedly make seed capsules and seedlings, suggesting orchids that adapt well to the restored environment, while identifying other species that have not been able to reproduce. The restored forest is located at 950 meters altitude in the Ecuadorian Andes, and most orchids were transplanted from nearby montane and lower montane cloud forests. New observations of visiting insects and potential pollinators are also included for orchids (Xylobium spp., Paphinia spp., Maxillaria spp.) which have been observed seeding in the restored forest.

Survival and reproductive success of southern scrub-robins (Drymodes brunneopygia) in different types of habitat in the North Murray Mallee, South Australia

Barker, Andrew; David C. Paton, Nigel Willoughby
The University of Adelaide

Southern Scrub-robins (Drymodes brunneopygia) and other shrubby understory dependent birds are rapidly declining in the North Murray Mallee of South Australia owing to preferential habitat clearance for agriculture. Prior to European colonization, it is estimated that approximately 170,000 hectares (out of a total land area of 681,000 ha) of suitable habitat existed for these birds. Currently, all the Scrub-robins in the region (approximately 100 birds) are now confined to one privately owned farm 2000 hectares in size. These birds were color-banded and regularly observed over three years to obtain habitat, survival and productivity data in order to inform revegetation projects aimed at conserving this species. At multiple spatial scales (landscape, patch and territory), the production of more, longer lived offspring was positively related to large areas of eucalypt woodland with a dense shrubby understory of Acacia sclerophylla (+35 year old naturally regenerated farmland) or Leptospermum coriaceum (old-growth shrubby woodland). These shrubs differ from other, less favored understory species structurally and grow in large, dense clumps of numerous conspecifics. Strategic restoration and revegetation of woodlands incorporating these features will be necessary to expand and re-establish the distribution of Scrub-robins and other shrubby understory dependent birds throughout the region.

Why are southern scrub-robins disappearing from the North Murray Mallee?

Barker, Andrew; David C. Paton, Nigel Willoughby
The University of Adelaide

Over 97% of eucalypt shrublands have been cleared from the North Murray Mallee region of South Australia. As a result, since 2008 a number of isolated groups of Southern Scrub-robins (Drymodes brunneopygia) have disappeared entirely from the region (total area = 681,000 hectares), confining the existing populations to just one privately owned farm 2000 hectares in size. Color-banding and tracking data showed that the abandoned patches consisted of small groups of home ranges occupied by lone males isolated from other, stable patches of Scrub-robins by distances greater than 855 m, which is the distance of the longest inter-patch movement recorded by any bird throughout the study. The abandoned home ranges also lacked the necessary amount of surrounding key habitat (Acacia sclerophyllaor Leptospermum coriaceum) in the required densities to support the establishment of neighboring permanent groups of conspecifics. Within the surviving population, lone males abandoned isolated home ranges in favor of territories with (or near) resident females. Collecting information specific to the system in decline is an important component of addressing biodiversity loss in fragmented landscapes.

Manual for ecological restoration of disturbed ecosystems of the Distrito Capital (Bogotá-Colombia)

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Pontificia Universidad Javeriana

The “Manual for Ecological Restoration of disturbed ecosystems of the Distrito Capital” is a publication that resulted from the need for new theoretical and practical tools for restoring disturbed ecosystems in the Bogotá Distrito.
Capital, which was conducted under the agreement 017/2008 concluded between the District Department of Environment and the Ecological Restoration School of the Pontificial Javeriana University. Chapter I provides the conceptual foundations and focuses on the theory of disturbance and succession; Chapter II presents the physical, biotic and socio-economic aspects of Capital District; Chapter III provides an approach to the role of State and civil society in environmental management planning and ecological restoration in phases, the IV develops the steps of an ecological restoration project; in the Chapter V we show the steps to carry out projects on restoration ecology; the Chapter VI show some strategies for ecological restoration of disturbed areas different, Chapter VII shows some examples of ecological restoration projects developed in the District Capital. Finally, we present 37 records of species of plants of both the Andean forest and wasteland near Bogotá, which could be used in ecological restoration projects.

Regeneración de los pastizales impactados en un área del Sur de Brasil

Barrotto do Carmo, Marta Regina; Shyguek Nagazak, Alves Miyamoto, Adriane Ribeiro da Silva, Berenice Nágela Silva de Lima
Universidade Estadual de Ponta Grossa

Los pastizales naturales representan la principal cobertura vegetal no forestal en el sur de Brasil. Sin embargo, esta fisonomía está experimentando una fuerte influencia antropogénica, causando una reducción significativa de la vegetación original. El objetivo de este trabajo fue investigar áreas del 'Parque Estadual de Vila Velha', municipio de Ponta Grossa, Paraná (Brasil), para evaluar las posibilidades de regeneración de zonas afectadas por la agricultura y el turismo. Para cada tratamiento (vegetación nativa, impacto agrícola, impacto por turismo) se asignaron 4 bloques de 5x5m, subdivididos en 50 parcelas de 1x1m. En cada bloque se seleccionaron al azar 10 parcelas (total 40m²). Se registraron en total 178 especies pertenecientes a 21 familias. Las áreas con vegetación nativa fueron las que mostraron el mayor índice de diversidad (H'=3,34), seguidas por el campo afectado por el turismo (H'=2,45) y por la agricultura (H'=1,31). El impacto de la agricultura redujo la heterogeneidad florística típica de los campos del sur de Brasil y condujo a la dominancia de pocas especies. A pesar de la alta riqueza de especies en las áreas impactadas por el turismo, es preocupante la amplia cobertura de especies invasoras, *Melinis minutiflora* P. Beauv. Y *Urochloa decumbens* (Stapf) R.D. Webster, ya que son muy agresivas y afectan la vegetación nativa. Se concluye que deberían tomarse medidas de control antes de que extensas áreas sean invadidas, reduciendo aún más la diversidad local.

Coolo-nomics

Bates, Albert; Erich Knight, Ronal W. Larson, Nathaniel Mulcahy, Jeffery Wallin, Rob Wheeler
Global Village Institute

“Cool food” cooperatives have emerged to reinvigorate the rural economy of Japan and restore satoyama ecosystems. Bamboo is harvested for biochar, reburied for fertilizer and carbon credits, and cabbages sown. In 2009, Cool Slaw was sold at a premium by a supermarket chain. The origin of the cool foods revolution was not in the bamboo forests of Japan, but rather from the practices of soil management discovered more than 8000 years earlier. In pre-Columbian times, Brazilian peoples took the refuse from their kitchens — fish and animal bones, broken pottery, nut husks, turtle and oyster shells, and cinders from their fires — and built dark earths. When these people vanished, victims of the Columbian Encounter, their soils — extremely rich in phosphorus, nitrogen, potassium, and carbon — generated the Amazonian rainforest so quickly that Europe literally froze. Today that same process is being reconstructed by ecovillages and ‘Transition Towns’. The Global Ecovillage Network is working with the government of Senegal to convert 28,000 villages to ecovillages with tree planting to combat desertification. In Haiti, pelletized debris fuels smokeless cooking and pyrolytic byproducts filter water, compost sewage, and reforest the island. In Belizean and Chines ecovillages, discarded cacao pods and coconut husks have become tools for saving coral reefs, starving the atmosphere of gigatonnes of greenhouse gases while reinvigorating salted soils, even phyto-remediating radionuclides. In this poster we describe integration of cultural and scientific goals through a holistic, ‘cool’ branding approach; rebalancing ecosystems by carbon farming, agroforestry, biochar energy enterprises and cool living.

Producción de hojarasca en dos formas de restauración forestal en una zona montano bajo de Costa Rica

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La producción de hojarasca (PH) es un componente importante en la productividad primaria neta y su cuantificación permite comprender la capacidad de almacenamiento de biomasa en los ecosistemas forestales y sus implicaciones en la producción de CO₂. La PH puede variar con las formas de restauración forestal utilizadas en un sitio. Se midió la PH en dos distintos ecosistemas forestales restaurados: un tacotal (Ta; 14 años de abandono) y un cipresal (Ci, 35-40 años), y se utilizó un tercer sitio como ecosistema de referencia (bosque maduro; Br >50 años), todos ubicados en el Valle Central Oriental de Costa Rica. Se utilizaron 20 recolectores (0.25 m²) de hojarasca ubicados al azar en cada ecosistema. Se recolectó el material cada mes por un periodo de seis meses. Se calculó el índice de área foliar y el índice de claros a partir de fotografías hemisféricas tomadas sobre cada recolector y se correlacionó con la PH. El Ci presentó la mayor PH (5,73 Mg/ha), seguido del Ta (5,17 Mg/ha) y el Br (4,84 Mg/ha). Se encontró una baja correlación de menos del 30 % entre el índice de claros y la producción de hojarasca. Parece que la PH de los tres ecosistemas no se relaciona con la apertura ni la densidad del dosel, esto puede deberse al poco tiempo evaluado y el efecto de otras variables no contempladas.

Is restoration an important component in the local conservation discourse?
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The conservation discourse suggests that successful management plans should incorporate and represent the interests of people involved in the local conservation process. However, programs in Protected Areas (PA) often fail to evaluate the perceptions stakeholders have on what should be the PA’s priority goals (including restoration projects), and how these should be achieved. This study examines the diverse visions and expectations of actors involved in local conservation of a PA in the Yucatan peninsula, Mexico. Through participatory observation and semi-structured interviews, we identified the interests and perceptions on conservation in the PA of five different groups important for the local conservation process: 1) local people; 2) conservation government agency; 3) scientists; 4) non-governmental organization, and 5) tourist agency. All actors agreed that the PA should achieve two main goals: 1) to conserve biodiversity and, 2) to improve local welfare and development. In general, habitat restoration and native species introduction were not an important component of the conservation discourse. In fact, restoration was mentioned only by one representative of the conservation government agency as an example of the activities important to preserve the forest. In general, traditional agriculture was perceived as the main threat to forest conservation, while ecotourism as the most environmentally friendly option for protecting the forest and promoting local development.

Assessment of environmental degradation the Veredas of the northwest of Minas Gerais – Brazil
Borges da Costa Milanez, Cinthia; Glênia Lourenço da Silva, Paulo de Tarso Amorim Castro, Sérvio Pontes Ribeiro
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The veredas are an important floodplain ecosystem in the Cerrado (Brazilian Savanna), being defined by shallow valleys with smooth slopes concave in shape and covered by sandy soils, with high concentrations of peat. The veredas are considered protected areas due to their environmental aspects, such as recharge of aquiferous reservoirs. This study aimed to evaluate the environmental degradation of the veredas based on geological and geomorphological conditions and invertebrate bioindication. We selected two veredas impacted by eucalyptus monoculture and two other well preserved, independent areas. Mineralogical and granulometric analysis were carried out by soil sampling and measurements of permeability. The preserved veredas had low permeability, a typical result of a savanna area where the soil remains waterlogged throughout the year, and which has a fine grain with a high concentration of peat. Areas of eucalyptus monoculture had a high permeability, suggesting that the soil management for the eucalyptus plantation may have changed general soil traits. The data suggest that eucalyptus plantation does indeed contribute to reducing the soil capacity of retaining water, causing an atypical drought in this ecosystem. A total of 5,779 ants were sampled, belonging to 30 genera and 133 morphospecies. Despite the high diversity present even in the impacted veredas, which suggest resilience of the fauna to the surrounding impacts, subtle changes in the species distribution among functional guilds ought to reflect the observed changes in geomorphologic conditions.

Environmental restoration of fluvial terraces in the Upper Jequitinhonha River (Brazil), based on biomonitoring after dredging for diamonds
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River ecosystems are characterized by high resilience to non-catastrophic natural hydrological disturbance. In the case of anthropogenic disturbances, the system may be more severely affected, thus requiring management for specific habitat restoration. Procedures in dredging rivers can change the fluvial geomorphology and riparian vegetation to a stage unlikely to recover. This study investigates the patterns of recovering of river terraces in the Jequitinhonha River after dredging for diamond extraction. Eight areas of the river bank were selected to assess the stage of natural succession after interventions. Samples of the sediment were collected for granulometric and mineralogical analysis, and permeability tests carried out in the field. Ant assembly was used as biological indicators of recovery. The rocks which compose the studied areas are quartzite and schist, with grains between 0.2 and 0.06 mm. 10,860 ants were sampled, belonging to 24 genera and 45 morphospecies. Many collected genera (33%) had already been sampled in a 5-year monitoring program of the area, but the increase in diversity was remarkable, even though overall species richness is still low. In the rainy season the nutrients and finer sediments are leached into the river, which has stopped natural succession on the riverbank. Ant fauna suggest that full recovery may not be possible, although some environmental improvement may be observed in the ecotones with natural vegetation.

**Myrmecofauna as biondicators of environmental impact and for characterization of forest rehabilitation processes**

Borges da Costa Milanez, Cínthia; Sérvio Pontes Ribeiro, Nádia Barbosa do Espírito Santo, Alexandre Cortez, Silvana Castro, Glânia Lourenço Silva, Roberth Faguandes Souza, Flávio Siqueira de Castro

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This study was part of an environmental assessment impact of bauxite mining within a national forest in the Amazon. The sampling protocol was composed of transects of 100 m with sampling points at each 10 m, distributed along 1 km line, in order to represent the three impacted habitats length: “igapós” (creeks), plateaus, and transition slopes. Soil and trunk sardine/honey baits were set and ants collected after 40 min in dry and wet season of 2006. Two replicates of the protocol were set in each of the six studied plateaus. A similar sampling effort was set in restored forests after mining, with 2-20-30 years after restoration started. We sampled 61,631 individuals distributed in 35 genera and 209 species. Species richness varied significantly between the plateaus, but no difference in diversity was observed between the three habitats. There were no significant differences between the plateaus and "igapós" regarding the species composition either. However, the composition of morphospecies of *Pheidole* separated notably each plateau and their zones of transition from one another, as well as "igapós" from these habitats. On the other hand, the restored forests presented a completely different species composition. Discriminant analyses evidenced that the older restored forests are, the more different its fauna is. These results point to a failure in reproducing the original conditions of this forest, and evidences the fact that such mining impact is unrecoverable.

**Local adaptation and plasticity of *Euterpe edulis* (Arecales) and their importance for conservation and restoration efforts in the Atlantic Forest biome of Brazil**

Brancaion, Pedro

Universidade de São Paulo

We report here on an experimental study designed to investigate whether the occurrence of the endangered palm *Euterpe edulis* in three different forest types of the Atlantic Forest biome (Restinga Forest, Atlantic Rainforest and Seasonally Dry Forest) is made possible by phenotypic plasticity, or local ecotypic adaptation, or both. We concentrated on seedling establishment and sapling growth rate as key life history traits that are known to be critical to persistence in tropical forest biomes. A common garden experiment and reciprocal transplants using seeds and one-leaved seedlings were carried out with *E. edulis* populations growing in Natural Reserves of the three cited forest types in São Paulo State, Southeastern Brazil. Fitness during seedling establishment and saplings growth was evaluated for a period of 270 days after sowing and 12 months after transplant, respectively. The results indicated a home-site advantage for seedling establishment at Seasonally Dry Forest and Atlantic Rainforest, while local adaptation was observed during sapling growth in Restinga Forest. However, the adaptive traits evaluated in the common garden did not differ among populations. Phenotypic plasticity both in seedling establishment and in sapling growth rate apparently facilitates the occurrence of each *E. edulis* population in the various forest types under investigation here. Therefore, the evidence of ecotypic differentiation for *E. edulis* indicates that the different forest types of the Atlantic Forest biome should be treated as separate seed zones when planning strategies of both ecological restoration and conservation biology.
Common-garden experiments can help identify adaptive genetic divergence in long-lived tropical plant species to support ecotypes use in ecological restoration

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The use of appropriate local ecotypes can enhance the effectiveness of reestablishing native plant populations in degraded areas targeted for ecological restoration. However, the identification of adaptive genetic divergence among provenances is not easy, especially when it comes to tropical trees. In this study, we sought to investigate the effectiveness of common-garden and short-term reciprocal transplant experiments to identify genetic, adaptive divergence in different populations of Queen-palm (*Syagrus romanzoffiana*). Seed harvesting was carried out in southeastern Brazil, in natural remnants of Seasonally Dry Forest, Restinga Forest, and Cerrado Forest. Under common-garden conditions, we examined the length of the cotyledonary petiole of 3 month-old seedlings, and several adaptively significant traits, of 10-month-old nursery-grown saplings of all three above-mentioned seed provenances. Additionally, reciprocal transplants were carried out during 10 months for Seasonally Dry Forest and Cerrado Forest seed lots. In the common-garden experiments, Restinga Forest seedlings had significantly shorter cotyledonary petioles and Cerrado Forest saplings showed approximately 40% higher values for root, leaf blade, shoot, and total dry mass, although adults at the Seasonally Dry Forest showed larger biomass than those in Cerrado Forest. However, saplings did not express adaptive genetic differences in reciprocal transplants. Hence, common-garden experiments under nursery conditions can be advantageously used as a complementary technique to identify adaptive genetic divergence in long-lived tropical plant species, when the use of reciprocal transplants for these species is problematic.

Acumulación de biomasa en cinco especies pioneras potenciales para la restauración de bosques degradados al norte de Venezuela

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Las tasas actuales de deforestación en el trópico superan la resiliencia de los ecosistemas, produciéndose una degradación sostenida; esto conlleva a plantear estrategias de recuperación de bosques urgentemente. La restauración de bosques asistida, utilizando especies pioneras autóctonas de las áreas degradadas, es necesaria. En el Neotrópico existen muchas especies promisorias, aunque la información disponible suele ser escasa. Por tanto, es imperante el estudio de características de crecimiento y capacidad de tolerancia de estas especies. En este trabajo, en condiciones de vivero y con un diseño al azar, nos propusimos evaluar el efecto del robustecimiento de semillas sobre la biomasa aérea y subterránea, longitud radical y la relación vástago:raíz, bajo riego interdiario (riego) y semanal (sequía), en cinco especies (*Prosopis juliflora*, *Machaerium biovulatum* [*Fabaceae*], *Ochroma pyramidale* [*Bombacaceae*], *Heliocarpus americanus* [*Malvaceae*] y *Guazuma ulmifolia* [*Sterculiaceae*]). El robustecimiento de semillas favoreció la acumulación de biomasa aérea en Ochroma bajo riego, en *Guazuma* y *Heliocarpus*, ocurrió en sequía. La biomasa de raíces en *Guazuma* y *Ochroma* presentó la mayor acumulación bajo robustecimiento en sequía, respectivamente. *Heliocarpus* presentó la mayor acumulación de raíces en el tratamiento control con riego. La longitud de raíz en *Guazuma* y *Ochroma* fue mayor en el tratamiento control con sequía y riego, respectivamente. Estos resultados permiten establecer planes de manejo especie-específico bajo condiciones de vivero, optimizando la asignación de recursos (dedicación, agua, tiempo).

Sobrevivencia de especies arbóreas nativas del bioma cerrado utilizadas en la restauración de un área de pasto abandonado

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La siembra de pastos es una de las principales causas de la pérdida de vegetación nativa del Cerrado. Sin embargo, después de que esas áreas son abandonadas, se convierten en áreas importantes para la implementación de acciones de restauración. Es por esto, que el objetivo de este estudio fue evaluar la sobrevivencia de especies introducidas en áreas de pasto, para lo cual, fue realizada una siembra en Paracatu, Minas Gerais (Brasil), basada en el modelo MDR-Cerrado que prioriza el uso de especies nativas de las formaciones sabánicas y forestales del bioma. Para ello, se utilizaron 911 plántulas de 23 especies, siendo seis de Cerrado, cinco de Mata de Galería y doce de Mata Seca, cuya evaluación fue realizada 16 meses después de la siembra. Los resultados mostraron que la tasa de sobrevivencia (TS)
fue de 88% para Mata Seca y 72% para Cerrado, ambas significativamente superiores a la TS de Mata de Galeria (40%). De las especies de Mata Seca, diez presentaron TS superior a la tasa promedio (75%). La TS más baja fue de Luehea paniculata (58,33%). Cuatro especies del Cerrado, tuvieron una TS mayor a la tasa promedio, sobresaliendo Hymenaea stigonocarpa (98,5%). La menor TS fue de Machaerium aculeatum (4,35%). Por otro lado, ninguna de las especies de Mata de Galeria presentó una TS superior al promedio, siendo Schefflera morototonii (6%), quien presentó la menor TS. Este resultado demuestra la importancia de la selección y de la evaluación del desempeño de las especies nativas utilizadas en el trabajo de restauración.

**Sistema Mimosa-Islas de Recursos, modelo biológico para la restauración ambiental, Valle de Tehuacán-Cuicatlán, Puebla-Oaxaca, México**


Universidad Autónoma Metropolitana, Unidad Iztapalapa

Después de 11 años de estudio, se ha identificado que cuatro especies de *Mimosa (Leguminosae)* forman islas de recursos (IR), *M. lacerata*, **M. luisana**, *M polyantha* y **M. texana var. filipes*, en el Valle de Tehuacán-Cuicatlán (*endémicas-México, **endémicas-Valle). Estas especies son arbustos o árboles bajos (hasta 6m de alto), de copa amplia (hasta 6m²), con gran producción de semillas y rápida germinación (2,000-15,000 semillas por individuo/año), y consideradas como plantas multipropósito por los pobladores locales. Estas especies presentan un xilema mesófita y relativamente, son resistentes a la sequia (índice de vulnerabilidad de 1.6-2.2). En comparación con áreas carentes de vegetación o abiertas (AA), el sistema *Mimosa*-IR, no sólo es significativamente más rico en nutrientes debido a los procesos biogeoquímicos que se llevan a cabo ahí (mayor concentración y calidad de MO, C orgánico, C y N lábil, total y microbiano, mineralización de C y N, y de otros nutrientes como P, Ca, Mg, Na y K), sino en microorganismos (hongos micorrizógenos arbusculares, hongos, cianobacterias, bacterias y algas), mesofauna (e.g. colémbolos, ácaros, nemátodos y anélidos), plantas (e.g. briófitas y angiospermas) y líquenes. Asimismo, las plantas que generan este sistema, forman micorriza arbuscular y, en ocasiones, llegan a establecerse costras biológicas. Este sistema favorece la conservación del suelo y de la biodiversidad, por lo que proponemos que el sistema *Mimosa*-IR sea considerado como un modelo biológico para la restauración ambiental en el Valle.

**Genetic population study with two mangrove species showed depleted diversity in Rio de Janeiro populations of L. racemosa**

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Although mangroves have great ecological importance, in Rio de Janeiro anthropological actions have degraded most of this ecosystem. Local genetic diversity studies on mangrove species are necessary in order to set priority areas for their conservation and restoration. Our aim was to assess the genetic diversity of mangroves in Rio de Janeiro State and give ways to their conservation and restoration. We analyzed seven *Avicennia schaueriana* populations (96 plants) and six *Laguncularia racemosa* populations (113 plants) from Rio de Janeiro State, using ISSR markers. *Laguncularia* racemosa had the lowest diversity in Guaratiba and the highest diversity in Paraíba do Sul. Total diversity of *L. racemosa* (HT) was 0.2193 and the mean population diversity (HS) was 0.1568. The genetic differentiation between populations (GST) was high: 0.2852. For *Avicennia schaueriana*, Guaratiba had the lowest diversity while Rio das Ostras had the greatest diversity indices. The HT and HS indices for *A. schaueriana* were 0.4152 and 0.3305 respectively, while GST was 0.2001. Unexpectedly, *L. racemosa* plants, which have wide-range distribution and are mono-specific, are less diverse than *A. schaueriana* plants that have restricted distribution in the America continent and have competing sympatric species. Probably, *L. racemosa* populations have lost part of its original genetic diversity. In order to understand how this happened, further studies should be performed. We showed that *L. racemosa* diversity is impoverished in Rio de Janeiro and consequently it should have a specific conservation plan based on population reinforcement and restoration in order to improve its diversity.

**Evaluación de la efectividad de la exclusión de ganado, como una medida de restauración de pastizales en el Altiplano del norte de México**

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Debido a la gravedad de los problemas ambientales y socio-económicos causados por los procesos de desertificación que se presentan, principalmente en las zonas áridas, resulta imperativo proponer acciones que permitan detener o revertir la pérdida de potencial productivo de estas áreas, las cuales se caracterizan por estar habitadas generalmente por las poblaciones más pobres y vulnerables. Diversas instituciones, dependencias de gobierno y organizaciones no-gubernamentales han destinado recursos al establecimiento de prácticas con el fin de detener estos procesos de degradación. Sin embargo, la mayoría de las veces no existe un seguimiento que permita evaluar la efectividad de dichas acciones. En esta investigación se evalúan los cambios en las condiciones edáficas y de vegetación en áreas de pastizal halófito - gipsófilo del altiplano mexicano, en el estado de San Luis Potosí, tras seis años de haber sido excluidas al pastoreo y se comparan con áreas testigo con la finalidad de tener una primera estimación de la efectividad de las acciones realizadas. Para determinar la salud y el buen funcionamiento del ecosistema se utilizó la metodología propuesta por Tongway obteniendo, a partir de mediciones de cobertura vegetal, densidad de especies y distribución de interparches, los índices de infiltración, de ciclo de nutrientes y de estabilidad del suelo. Adicionalmente se tiene datos de contenido de materia orgánica y grado de compactación del suelo.

**Jardín recreativo “Iguana-DAMC” en la División Académica Multidisciplinaria de Comalcalco (DAMC) de la Universidad Juárez Autónoma de Tabasco (UJAT)**

Carmona Díaz, Elizabeth; Patricia Román SantaMaría, Teresa Ramón Frias, José Alfredo de la Cruz Navárez, Gustavo Morillo Flores, María Antonia Jiménez Santos, Mirelda Velázquez Gutiérrez

Universidad Juárez Autónoma de Tabasco

El profesional encargado de la educación ambiental en la División Académica Multidisciplinaria de Comalcalco (DAMC) de la Universidad Juárez Autónoma de Tabasco (UJAT) diseñó y creó un Jardín Recreativo el cual permite el enriquecimiento lúdico, cultural, social y educativo de la comunidad universitaria. En la creación de este jardín participó activamente el alumnado, utilizando para ello material típico de la región y material reciclable. La flora sembrada es característica de la zona, dentro de ella están diversos tipos de orquídeas. Se creó y nombró al Jardín Recreativo Iguana-DAMC por la abundancia del reptil en la región; dicho jardín cuenta con palapas, mesas, bancos individuales, bancas colectivas, macetas, canastas florales, árboles, plantas y flores de la región, con ello se logró la integración del conocimiento ecológico local y tradicional a un escenario real y agradable que provee de confort a la comunidad universitaria de la División. Se logró la sensibilización de los actores principales de la educación superior, permitiendo comprender las relaciones de interdependencia con su entorno y la importancia de la restauración ecológica.

**La educación ambiental en la recuperación y conservación de un fragmento forestal ubicado en zona urbana, en la ciudad de Araras/ SP – Brasil**

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El proceso desordenado de los asentamientos urbanos, junto con la falta de planificación ha llevado a una disminución de los espacios naturales, provocando la fragmentación forestal. Esta fragmentación es aún mayor cuando se entendida en el zonas urbanas. Este trabajo fue realizado en un fragmento forestal ubicado en zona urbana de Araras/SP – Brasil y con la comunidad local. El objetivo fue la sensibilización y difusión de informaciones sobre la recuperación forestal y la importancia ecológica de los bosques en el contexto urbano, para que los residentes puedan actuar como conservadores de estas áreas. Durante el trabajo, la comunidad se mostró comprometida y participativa. Análisis de la percepción ambiental reveló que 72% de los entrevistados creían que el bosque hacía parte de su historia personal, 64% considerarán importante su existencia y 89% tenía un gran interés en las acciones para gestión y uso de la zona, propusieron aún la integración de el bosque con la comunidad, por ejemplo, mediante la creación de senderos. Como resultado directo de las acciones en educación ambiental, estudiantes realizaron la plantación de 250 árboles dentro del fragmento. Enfatizamos la necesidad de realizar proyectos en educación ambiental en el contexto urbano, que ayuden e informen sobre la importancia de la comunidad local en la conservación y mantenimiento de los fragmentos forestales, para que las personas no se sienten excluidos del proceso de restauración, pero participantes en todas las etapas, desde la planificación, la restauración, mantenimiento, incluso el uso futuro de estas zonas.
**Indicator plant species to evaluate restoration success in gypsum quarries of semiarid environments**

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Open cast mining generates a strong environmental impact on gipsiferous ecosystems. A commonly accepted goal of the rehabilitation of mined lands is to restore the structure, diversity, function and dynamics of the disturbed ecosystem. However, every condition of each ecosystem attribute and each species cannot be easily monitored. ‘Management indicator species’ (M-IS) are those that reflect the effects of a disturbance regime or the efficacy of efforts to mitigate disturbance effects, including ‘recovery indicator species’ (R-IS), which are considered useful in assessing the effectiveness of mine site rehabilitation. The idea of R-IS is attractive, because it would be much easier and less costly if a single, most sensitive species could be used. Nevertheless, it is essential to specify which abiotic or biotic factors the species are being used to indicate. Plant community patterns were used to identify M-IS in order to assess restoration success in a 10-year survey at gypsum quarries in a semiarid region of Southeast Spain. Since ecosystems are quite complex, additional indicators at different levels of biological organization must be considered extremely useful and are also proposed. Further plant ecology research relating to the models of mechanisms (facilitation, tolerance and inhabitation) is also needed to explain how indicator species affect successional changes.

**Floristic changes and regeneration of semiarid shrubland steppes in rehabilitated oil/gas fields of Northern Patagonia, Argentina**

**Castro, Martín Leandro; G.A. Zuleta, M. Ciancio, M.T. Junges, A.A. Pérez, P. Tchilinguirian**
Universidad Maimónides

Overgrazing and hydrocarbon exploitation generate the most significant environmental impacts in the Monte Austral. This ecoregion harbours the most productive oil/gas area in the country; more than 12,000 active wells. To construct each drilling location the natural system is completely destroyed within an area of at least one hectare/well. The natural recovery process of disturbed areas is very slow in arid ecosystems due to the low resilience of the system. In this context, the focus of this research was to determine patterns of post-disturbance plant succession in scarified soils, a mechanical decompaction technique widely applied in the region since 1998 but never validated. In 190 sites scarified during 1998-2010, ecological attributes were quantified (Braun-Blanquet adjusted method). At each well location three sites were evaluated: (1) natural, (2) treated, and (3) operational (disturbed areas without treatment). A discriminant analyses (DA) allowed identifying cover and diversity (H index) as the best predictors for distinguishing between those three sites. Scores obtained in DA for the canonical axis 1, which accounts for 97% of the among-site variability, were considered as an indicator of ecological restoration. In treated areas this indicator was significantly and positively associated with time since the technique was applied. However, even in locations scarified 8-12 years ago, the ecological restoration levels were lower than standard values in natural areas. Pioneer or ruderal species (*Atriplex, Senecio, Hyalis, Glandularia, Salsola, Grindelia*) predominate in all rehabilitated locations regardless the restoration time. Implications of scarifying techniques for environmental management are discussed.

**Tipos funcionales de plantas respuesta en una cronosecuencia producto de la agricultura migratoria en Calakmul, Campeche**

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La evaluación de la respuesta de las especies ante factores de perturbación, incluyendo el cambio climático, requiere una síntesis de sus propiedades o rasgos funcionales. El enfoque de tipos funcionales de plantas (TFPs) puede ser la base para propuestas de restauración de acuerdo al proceso ecológico o servicio ecosistémico de interés. En este estudio se evaluó la respuesta de un bosque tropical seco en términos de la diversidad de TFPs, a través de una cronosecuencia producto de la roza-tumba-quema (RTQ), con base en rasgos funcionales asociados a dicha perturbación y se determinó y comparó la composición de estos TFPs. El trabajo se desarrolló en la zona de influencia de la Reserva de Biosfera Calakmul donde se establecieron 16 parcelas 50 m x 50 m en tres rangos de edad (4-6, 14-16 y 19-21 años) y en bosque primario. Se muestreó la vegetación con dap ≥5 cm. Para cada especie se determinaron cuatro rasgos funcionales: densidad de madera, altura máxima, fenología foliar y agente dispersor. Así, se determinaron seis TFPs. De acuerdo a los análisis de varianza y de correspondencia, la altura máxima y las variables categóricas fueron útiles para la separación de grupos. El ANOVA para la composición diferenció los TFPs a través de la cronosecuencia. De modo que la reducción del periodo de barbecho o el aumento de la intensidad de
perturbación puede ocasionar la pérdida de TFPs afectando la recuperación del bosque y las comunidades humanas que dependen de él.

**Monitoring ecological restoration in the state of São Paulo, Brazil**

**Chaves, Rafael; Thiago Uehara, Denise Sasaki, Claudia Sato**

Secretaria do Meio Ambiente do Estado de São Paulo

Monitoring restoration projects is a great challenge all around the world. Nevertheless, there is a lack of powerful, uncomplicated and widely acceptable indicator systems for monitoring. Besides developing policies on how to conduct restoration projects (i.e. Resolution 8/2008), the Brazilian state of São Paulo has compiled indicators aiming at the verification of public funded restoration projects as well as those compulsories due to law determinations. Experts from universities, governmental agencies, NGOs and the private sector have met in a workshop to propose monitoring protocols and indicators through which one could efficiently identify trends in ecosystem quality over time. Structural indicators at community level (e.g. total vegetation cover, vertical heterogeneity and life form spectrum) were preliminarily considered the most feasible ones. Indicators of community functioning and composition such as regeneration and diversity of functional groups were proposed as well. The monitoring protocols will be consolidated to join the normative instruments aiming at increasing the effectiveness of restoration projects. They are expected to contribute towards a monitoring system as must independent as possible of the operational aspects of the projects, focused on the targets and goals of ecological restoration. Finally, the protocols are expected to be strategic to monitor payment for ecosystem services projects recently launched by the State Government.

**Efecto de borde y de zonas abiertas sobre el crecimiento y supervivencia de especies dominantes del bosque de la Barranca de Tarango, Cd. de México**

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Los remanentes de bosques en paisajes fragmentados tienden a ser cada vez más pequeños, aislados y de forma irregular, lo cual incrementa los efectos de borde. Diversos estudios han mostrado que los bordes pueden representar zonas con condiciones menos drásticas que los sitios abiertos para el establecimiento de las plantas. El objetivo de este estudio es evaluar el efecto de borde y de zonas abiertas en el crecimiento y supervivencia de tres especies de la Barranca de Tarango, con el fin de determinar las zonas más adecuadas para el establecimiento de las mismas. Se seleccionaron las especies *Quercus rugosa*, *Crataegus mexicana* y *Prunus serotina subsp. capuli*, debido a que son nativas de la barranca y han sido catalogadas como potenciales para la restauración de zonas perturbadas. Dentro de cada sitio se establecieron 4 parcelas, 2 en sitios de borde y 2 en zonas abiertas. En cada parcela se plantaron 120 individuos de las tres especies en distintas densidades. La zona de borde y la zona abierta se caracterizarán mediante variables ambientales (temperatura y humedad relativa del aire, perfiles edáficos e incidencia lumínica). En general, todas las especies han respondido positivamente; sólo 6% se registraron como muertes o desaparecidas a cuatro meses de la introducción. Hasta ahora no hay ninguna diferencia en cuanto al crecimiento de los individuos entre ambas zonas. Las tres especies tienen la capacidad de rebrotar, sobre todo *P. serotina subsp. capuli*.

**Obras de restauración hidrogeomorfológica como estrategia para la rehabilitación del ecosistema de Tibanica**

**Chisacá Hurtado, Magda Liliana; Mary Luz Bedoya Álvarez, Sandra González**

Ecodes Ingeniería Ltda.

En Bogotá se han venido desarrollando estrategias para la protección de ecosistemas que conservan características naturales de la región. Este es el caso de los humedales de Bogotá, especialmente aquellos que a causa del crecimiento urbano desmesurado y de la falta de planeación han quedado inmersos en el casco urbano, ocasionando que se alteren sus funciones principales. Debido a lo anterior, se ha propuesto como principal objetivo la rehabilitación y recuperación de humedales en el distrito, entre los que se encuentra el humedal de Tibanica declarado (decreto 203-2003) en estado de alerta amarilla, por el grave estado de deterioro en el que se encontraba, a causa de las problemáticas de orden ambiental que posee este ecosistema. Debido a lo anterior se desarrolló el plan de manejo ambiental, dentro del cual se estableció una estrategia de rehabilitación y restauración, para lo cual se planteó la reconformación hidrogeomorfológica del humedal y el restablecimiento de la estructura y función del ecosistema acuático a través de la recuperación del cuerpo de agua, la rehabilitación del cordón ripario para la restauración, el enriquecimiento de la zona de manejo y protección ambiental y la reconformación de islas al interior del humedal (refugio, hábitat y percha para aves). Así mismo, este ecosistema es importante debido a la oferta
físico-biótica que presenta, siendo refugio de aves que se encuentran en algún grado de amenaza (*Cistothorus apolinari, Rallus semiplumbeus* y *Gallinula melanops*). Con el fin de proteger estas especies, se estableció la estrategia integral para la restauración ecológica.

**Los agaves como especies clave para la restauración de los ecosistemas áridos y semiáridos de México**

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Partiendo del hecho de que la mayoría de los agaves son endémicos, algunos de ellos restringidos a pequeñas zonas del país y aquellos que solo tienen reproducción sexual, se encuentran en potencial riesgo como los agaves pulqueros, mezcaleros e ixtleros que contribuyen al incremento de la biodiversidad, retención del suelo y agua; son altamente adaptables a cambios climáticos, siempre verdes, de larga vida, generosos con los recursos que proporciona a otros organismos, adaptaciones especiales a condiciones climáticas extremas y además tienen importancia cultural y económica para los pueblos asociados a ellos; por estas características son especies clave y altamente idóneas para la restauración de zonas áridas y semiáridas de México, por lo que deben de conocerse y reproducirse.

**Regeneration of soils and microgeomorphology in rehabilitated oil/gas fields of Northern Patagonia, Argentina**

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In southern Argentina, the Austral Monte ecoregion is characterized by semi-arid shrub steppes where the dynamics of the physical environment is controlled by ephemeral river systems that have areas of accumulation of sandy composition (alluvial fans) and clay (playa lake). Wind is an important agent, eroding sands of fans and depositing to leeward side of the vegetation forming mounds. These are islands of fertility, since they contain the highest concentration of nutrients, moisture and biodiversity within the matrix of bare soil (60% total coverage). Within this context, the focus of this research was to determine the variables and processes that control restoration of post-disturbance soil and mounds in oil & gas locations scarified since 1998. Geomorphologic attributes were quantified in 190 sites. At each well location three sites were evaluated: (1) natural, (2) treated, and (3) operational (disturbed areas without treatment). A discriminant analysis (DA) allowed identifying the number and height of mounds as the best predictors for distinguishing among those three sites. Scores obtained in DA for the canonical axis 1 were considered as an indicator of soil restoration. In treated areas this indicator was significantly and positively associated with time since the technique was applied. However, even in locations scarified 8-13 years ago, the environmental restoration levels were lower than the observed ones in natural areas. Higher similarity in soil conditions between treated and natural areas were observed in landforms with increased availability of sand. Implications of scarifying techniques for environmental management are discussed.

**Revegetación, con plantas nativas, de zonas áridas impactadas por la actividad minera en Catamarca, Argentina**

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La restauración de ecosistemas áridos afectados por diferentes actividades económicas, incluye la revegetación asistida para lograr su cometido. Sin embargo, se ha desarrollado muy poca investigación al respecto y más aún, sobre la utilización de especies nativas. Formas de reproducción, prácticas de manejo de suelos y sustratos, requerimientos hídricos y nutricionales mínimos que aseguren el establecimiento de las plantas son algunas de las incógnitas que deben develarse antes de comenzar con un programa masivo de revegetación de zonas áridas. Aquí se presenta la experiencia de un proyecto de desarrollo de metodologías de revegetación de zonas áridas impactadas por la actividad de una mina de cobre y oro en la provincia de Catamarca, Argentina. Resultados preliminares y avanzados, favorables y desfavorables, son expuestos y discutidos sobre esta experiencia que lleva más de dos años de desarrollo. Hasta la fecha se han seleccionado especies apropiadas y se cuenta con un conjunto de técnicas que han mostrado cierto grado de éxito en la revegetación de áreas con condiciones de suelo y clima extremos para el desarrollo de especies vegetales.
Use of fog incidence to determinate priority areas to restore hydrological services at a montane forest, Rio de Janeiro - Brazil

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In the montane forests of Rio de Janeiro, fog can provide water and humidity for vegetation, especially in the dry season. Some watersheds might receive this humidity with more intensity by its slope orientation. These areas seem to be more resilient and proper to restoration activities. This work aimed to identify differences between windward and leeward slopes in relation to fog incidence and indicate areas where restoration of hydrological services could obtain better and faster results. Study area is the Rio Grande watershed in an Atlantic Forest at Nova Friburgo, RJ, Brazil, enclosing part of Três Picos State Park. Slope orientation was obtained from ArcGis 9.3, and divided in: NW (0°-90°), SE (90°-180°), SW (180°-270°) e NW (270°-360°). Trade winds and fog blows in SW-NE direction. Epiphytes where used as humidity bioindicator. Forest fragments covered 53.8% of the watershed and 71% were at SW and SE showing that slope orientation affected forest resilience probably by highest fog precipitation. Using moss as fog collector we found that windward slopes intercepted an average of 0.04 lm-2 and leeward 0.02 lm-2. Epiphytic bromeliad abundance also was greater at windward slopes with 71% of trees with epiphytes against 46% at leeward slope. We conclude that extra humidity on leeward slopes can accelerate forest regeneration and it can be used as auxiliary parameter for watershed management, restoration decisions or even to select areas for implementation of programs of payment for ecosystem services.

Spatial characterization and risk assessment of gorse invasion (Ulex europaeus) in three villages near Bogotá, Colombia

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The characterization of the invasion of species at the landscape level is a critical step in deciding management strategies. Multi-criteria analysis, integrated with geographic information systems, provides an important tool for determining ecological dynamics and biological invasions. The purpose of this study is to characterize and evaluate the spatial pattern of invasion by Ulex europaeus (gorse) in three villages of Bogotá and perform risk assessment based on these patterns. To accomplish this, we georeferenced gorse patches and made the respective maps of the invasion. To make the risk assessment analysis, we applied multi-criteria methodology, with the variables that influence the colonization of gorse. Two scenarios were evaluated, one which includes the actual presence of gorse and another which excludes the presence of gorse and only takes into account the criteria considered. As results we found a relationship between factors such as type of coverage, type of ownership, distance to water sources and distance to roads. Coverages that have a higher invasion are those open and that allow light. In the case of risk assessment, it was found that in the first scenario the higher risk areas are adjacent to the current infestation. In the second scenario it is observed that areas with greatest potential risk to be colonized are open areas such as páramo ecosystem, which is particularly susceptible to the spread of this species. The development of these models is a very important step to determine actions at regional level and to establish management priorities of the invasion.

Programa extensiòn ambiental: Una iniciativa gubernamental para aumentar la cobertura forestal del Estado do Espírito Santo, Brasil

Costalonga, Schirley Aparecida; Maria Otávia Silva Crepaldi, Henrique Moreira de Melo Silva, Milesmarcos Gomes Pereira
Instituto Estadual de Medio Ambiente y Recursos Hídricos

Visando modificar la realidad del medio rural y contribuir para el aumento de la cobertura forestal, el Gobierno del Espírito Santo, a través del Instituto Estadual de Medio Ambiente y Recursos Hídricos (IEMA), en compañía con la empresa minera VALE, implementó en 2009 el Programa Extensión Ambiental, objetivando realizar la restauración de áreas de preservación permanente, exclusivamente la vegetación de ribera y entorno de nacientes. En este programa, el propietario rural interesado en recuperar su propiedad podrá contactar el IEMA o realizar su catastro online en el Banco de Áreas para Recuperación Forestal del Espírito Santo – BARFES. Técnicos de VALE o IEMA irán hasta el área catastrada para fornecer orientaciones técnicas y elaborar proyecto para el área en cuestión, informando cuáles serán las especies forestais utilizadas. Las especies forestais y el veneno para matar hormigas son donadas por VALE; para garantizar el comprometimiento del propietario, este se queda responsable por mantener la
Programa de restauración ecosistémica de áreas de restinga del Parque Estadual de Itaunas, Espírito Santo, Brasil

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Las restingas sufren con la fragmentación de sus hábitats. El Parque Estadual de Itaúnas posee áreas impactadas por fuego y acciones antrópicas; el trabajo analizó el éxito de la restauración en la restinga del Parque, utilizando la técnica de enriquecimiento con la siembra de más de 5,000 mudas nativas. Fueron monitoreados 80 individuos referentes a la primera siembra (febrero de 2009) y 200 de la segunda siembra (octubre de 2010), cuyo diferencial fue la utilización de polímero hidroretentor de acrilamida. Los individuos de la primera siembra pertenecían a ocho especies de cuatro familias botánicas. Después del 5º monitoreamiento, cerca de 50% de los individuos monitoreados estaban en buenas condiciones de desarrollo; de estas, *Anacardium occidentale*, *Protium heptaphyllum* y *Senna australis* tuvieron más éxito. Diez especies de cinco familias pertenecían al monitoreamiento de la segunda siembra, cuya mortalidad fue de 50% de los individuos monitoreados; *Abarema filamentosa*, *Eugenia punicifolia* y *Sophora tomentosa* tuvieron las mayores mortalidades (arriba de 50%), en cuanto *Schinus terebinthifolius* tuvo 100% de desarrollo. De 280 individuos monitoreados, el índice de mortalidad fue de 70%, considerado elevado pero explicado por la escasez del agua y nutrientes, acción del viento, exceso de luminosidad y arena que sufocaron las plantas. El polímero hidroretentor no fue eficaz en disminuir la mortalidad. Todavía, el programa de restauración del parque está evolucionando pues hay especies en rápido desarrollo, algunas ya en estadio reproductivo.

Floristic and phytosociology in a fragment handled by quilombolas in Santa Leopoldina, Espírito Santo, Brazil

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This study was conducted in a fragment of Atlantic Forest managed by quilombolas in Santa Leopoldina, ES, to determine its floristic diversity and successional stage. The chosen area is part of the "Centre of Endemism of Vascular Plants of the Serra do Mar", one of the "Priority Areas for Flora Conservation" and is also operating area of the "Ecological Corridors Project." Between August 2005 and February 2006 an inventory was conducted of 0.1 ha using 10 transects of 50 x 2 m, sampling individuals with DBH ≥ 2.5 cm. We recorded 297 individuals belonging to 54 species in 28 families. The predominance of species and individuals in the ecological group of an early secondary forest, the distributions of height and diameter, basal area per hectare (29, 77 m²) as well as the species with the highest Importance Value (*Zeyheria tuberculosa*, *Siparuna guianensis*,*Cedrela fissilis*) reference a secondary forest at an intermediary stage of natural regeneration. The value of Shannon diversity index obtained in this study (H' = 3.35) is average compared to other studies in the Atlantic Forest, with high equability (J = 0.84). Being a fragment very important for the quilombolas, mentioning how useful more than half of the native trees found in the fragment, as the potential for connectivity, studies and strategies for conservation and recovery of social and biological diversity are essential.

High persistence of weed species in Atlantic Forest restoration sites

de Assis Monteiro da Fonte, Maria Augusta; Lya Carolina da Silva Mariano Pereira, José Marcelo Domingues Torezan
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In ecological restoration with highly fragmented landscapes, weed species, as long as invasive exotic herb species, are a major concern due to competition with native plants. It is expected that the development of a forest structure drive weeds and other shade-intolerant exotic species to lower densities and even to local extinction, but most of these species can keep viable seeds in the soil, which could help it to re-colonize restoration sites after major disturbances, thus affecting native species. This study was aimed to estimate both weed and native species in soil seed banks of reforestation sites aging 91, 64 and 39 months. Twenty 0.25m² 5cm depth soil samples per site were collected and placed in a glass greenhouse being irrigated for 10min, four times a day during six months. All
emerged seedlings were counted and identified. Intermediate-age site showed higher total species richness than both the younger (Tukey, p=0.0037) and older site (Tukey, p=0.011), but ruderal species richness did not vary among sites (ANOVA, p=0.744). These results suggest that in reforestations older than seven years disturbance may be followed by re-infestation of weed species, and the low native seed abundance could not ensure forest disturbance recover.

Plants nativas de la sabana brasileña tolerantes a los metales pesados esenciales para la recuperación de las áreas degradadas por la minería de níquel, realizado en Goiás, Brasil

de Gois Aquino, Fabiana; Zenilton de Jesus Gayoso, Miranda Leide Rovênia, Miranda de Andrade Raiane Melo, Viana Thierry Becuер

Embrapa Cerrados

La sabana brasileña contiene gran diversidad y alto porcentaje de endemismo de herbáceas y arbustivas. Al mismo tiempo, este ecosistema concentra gran actividad agrícola, forestal y minería, amenazando esta diversidad única en el mundo. En el Brasil Central, existen suelos con una presencia natural de metales pesados, como el níquel, que en altas concentraciones pueden ser tóxicos para la mayoría de las plantas. Sin embargo, en Barro Alto/Goiás/Brasil, ocurre una vegetación adaptada a esta condición con especies hiperacumuladoras de níquel (>1% del peso seco de la planta). El objetivo de este estudio fue caracterizar la diversidad de plantas tolerantes a la toxicidad natural de níquel presente en la región de Barro Alto y definir las especies con potencial para utilización en proyectos de recuperación. El estudio fitosociológico se llevó a cabo en cuatro áreas cuyos suelos tienen una biodisponibilidad de Ni entre 100–500mg de Ni/kg en el suelo. Se utilizó el método de intersección en línea para el estudio cuantitativo de la vegetación herbácea-arbustiva. Para medir el potencial de acumulación de níquel en las plantas, se sometieron las muestras al reactivo dimetilglioxima. Se tomaron muestras de 152 especies y 40 familias. Se pudo establecer las especies más importantes para el proceso de recuperación por la minería de níquel, representadas en los géneros: Justicia (Acanthaceae), Porophyllum (Asteraceae), Heliotropium (Bignoniaceae), Manihot (Euphorbiaceae), Mimosa (Fabaceae) y Axonopus (Poaceae). El uso de plantas hiperacumuladoras de metales pesados en suelos contaminados es una práctica muy reciente y prometedora para usarse en el proceso de recuperación.

Restauración ecológica de áreas postaprovechadas de Pino en ambientes montañosos de Colombia
de las Salas, Gonzalo

Geoambiente LTDA

El proyecto de restauración ecológica abarca un área de 500 hectáreas cubiertas de Pino en un Parque Forestal de aproximadamente 3.000 hectáreas en la parte noroccidental de la Sabana de Bogotá. Los Rodales de Pinus radiata y P. patula presentan edades entre 30 y 49 años y su madera se está aprovechando en su totalidad. El objetivo central es el restablecimiento de los procesos ecológicos esenciales del ecosistema de manera que las áreas restauradas se mantengan y regeneren sin insumos externos o con una mínima cantidad de éstos, por medio de estrategias para la repoblación de especies leñosas nativas y el manejo de la regeneración espontánea. Entre agosto de 2009 y junio de 2011 se han replantado 160 hectáreas con 17 especies forestales nativas del bosque alto Andino con el fin de recuperar la biodiversidad de los sitios bajo restauración, reducir el riesgo de plagas y enfermedades, valorar su capacidad de atraer y albergar fauna y cubrir el suelo. El diseño de plantación fue una matriz de árboles espaciados 4 m al tresbolillo (625/ha) con altura mínima del tallo de 29 cm. Los resultados preliminares indican: i) un crecimiento en altura desigual con cuatro especies de mejor desempeño (Alnus acuminata, Smalanthus pyramidalis, Duranta mutisii, Escallonia floribunda ); ii) un crecimiento rápido y agresivo de especies invasoras; iii) aparición de un número importante de aves.

Propagación por semilla y por enraizamiento de estacas con AIB de Bursera fagaroides (Burseraceae), especie clave en regiones semiáridas de Jalisco, México
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Universidad de Guadalajara

La vegetación en regiones semiáridas de Jalisco, México se ha visto amenazada por diversos factores ambientales y actividades humanas. La propagación de especies como Bursera fagaroides es de gran importancia ya que ésta podría contribuir a la restauración ecológica de sitios perturbados. Se realizaron experimentos de germinación de semillas in vitro bajo condiciones de laboratorio y de enraizamiento de estacas en invernadero utilizando diferentes dosis de ácido indolbutírico (AIB) y sustratos. Los resultados mostraron que las semillas, con 6 meses de almacenamiento conservan viabilidad, mostrando incremento en peso y tamaño durante la inmibición: peso promedio inicial/final (0.04 gr/0.06 g); longitud inicial/final (5.33 mm/5.47 mm); inician germinación rápidamente (3-5 días) sin
tratamientos pregerminativos. Un 76 % de las estacas colectadas (27 cm longitud, 4 cm ancho) de árboles adultos, sembradas en tierra de maceta-agrolita (1:1) y con diferentes dosis de AIB iniciaron formación de yemas, ramas, hojas a los 21 días y raíces a los 45 días. Concluimos acerca de la utilidad de los dos procedimientos de propagación (por semilla y enraizamiento de estacas) para la regeneración de individuos y conservación de poblaciones de Bursera fagoides, especie de gran importancia en diversos aspectos (ecológica-medicinal-maderable), en las selvas bajas caducifolias de la región Altos Norte de Jalisco, México.

**Producción de Árboles Nativos NOA y restauración, reforestación y fijación de pendientes mediante la utilización de especies nativas en el diseño del paisaje**

Di Salvo, Nora Amanda
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Se pretende dar una breve información de la situación arbórea nativa de la Provincia de Salta, Argentina, con el objeto de divulgar y generar conciencia de la necesidad urgente de una Restauración Ecológica, para conservar el remanente de nuestros Bosques Nativos y restaurar sistemas naturales degradados, ya que resulta evidente el avance de la frontera agrícola en zonas tradicionalmente cubiertas de Bosques y Selvas. I parte: Trabajo detallado de vivirización, *Tabebuia impetiginosa*, zona de bosque y selva montana, cerros subtropicales húmedos, Lat.24º44 – Long.65º29, 1344msnm. II parte: Experiencia basada en principios de Jardinería Siglo XXI con implementación de flora nativa, técnicas de fijación de pendientes, restauración de suelos erosionados y diseño del paisaje. Se desarrolló conjuntamente mediante convenio científico-técnico entre la “Univ. Nac. de Salta – Empresa Complejo teleférico y Vivero San Lorenzo”, realizado en la Cumbre del Cerro San Bernardo de la Ciudad de Salta, 2000 al 2008, dejó como resultado que: 1. A los 8 años, se observó una relación más equilibrada con la incorporación de técnicas nuevas de jardinería y usos cuidadosos de los recursos naturales; comunidad urbano/rural con manejo de turismo sostenible; tratamiento y cuidado de especies nativas y biodiversidad; defensa de bosque nativo, revegetación. 2. Se redujeron riesgos mejorando funciones ambientales; absorción de agua/humedad ambiente; producción de oxígeno; regulación de humedad y temperatura; reducción y control de erosión.

**Importancia de las aves frugívoras para la dispersión y regeneración de especies nativas en un paisaje fragmentado de Bosque Chaqueño en Argentina**

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El Bosque Chaqueño (BC) de Argentina es una ecoregión muy importante por su gran extensión y biodiversidad. Recientemente ha sufrido una alta presión debido al avance de la frontera agrícola, encontrándose generalmente restringido a fragmentos rodeados de cultivos. En este escenario donde paisajes fragmentados son más frecuentes es imprescindible comprender cómo se mantienen procesos claves para la regeneración de muchos árboles nativos tales como la dispersión de semillas por aves. En el paisaje estudiado encontramos que las aves pueden moverse entre fragmentos e incluso utilizar árboles aislados como perchas, probablemente ayudando a mantener la conectividad funcional de las poblaciones de plantas que éstas dispersan. Evaluamos como varía la lluvia de semillas dispersadas por aves en siete fragmentos de BC de distinto tamaño (0,5-15ha) y en 11 árboles aislados (1 a 4 árboles), para complementar los resultados de movimiento ya obtenidos. Colocamos 168 colectores de semillas (50x50cm) para determinar abundancia y composición de las semillas dispersadas. Como resultados preliminares encontramos semillas dispersadas por aves bajo 6 árboles aislados y en todos los fragmentos. La abundancia de semillas no varió según el tamaño del fragmento, pero en fragmentos pequeños registramos una menor riqueza de especies ornitócas. Asimismo, en árboles aislados hallamos semillas de especies arbóreas cuya regeneración es importante porque se encuentran en baja abundancia. La capacidad de movimiento de las aves junto con el mantenimiento de una conectividad estructural -fragmentos cercanos y árboles aislados-podrían ser elementos claves para planificar estrategias de regeneración en paisajes fragmentados de BC que se deseen restaurar.

**Integrated restoration science in Western Australia**

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Kings Park and Botanic Garden, Australia

The Science Directorate at Kings Park and Botanic Garden has pursued an integrated approach delivering practical research outcomes for the conservation and restoration of Western Australia’s unique biodiversity and ecosystems including urban bushland remnants, agricultural and mined lands. Practical research nodes include: • Restoration
ecology – undertaking seeding, planting and topsoil handling, and researches factors limiting species establishment, plant community processes, and sustainability of restoration. • Seed science – researching seed quality, germination and dormancy, storage and longevity, seed ecology, seed enhancement technologies, and site delivery techniques. • Conservation genetics – researching seed sourcing issues, including genetic delineation of local provenance, maladaptation of non-local genotypes through reciprocal transplant trials, and the consequences of mixing genetically differentiated provenances such as outbreeding depression. • Conservation biotechnology – investigating in-vitro technology (micro propagation, somatic embryogenesis), cryostorage for ex situ conservation of endangered plant species, and mass production of recalcitrant taxa for broadscale restoration. • Restoration ecophysiology – researching key physiological markers that underpin establishment in native seedlings by understanding the relationship between plants and their growing environment. • Orchid conservation – researching orchid biology, ecology and evolution, propagation and pollination. • Pollination biology – understanding the role of pollinators in mating patterns, pollen dispersal, and pollinator communities in restored and natural populations. Our strong multi-disciplinary team of over 45 scientists and post-graduate students is internationally acknowledged in plant conservation science and has achieved world-class research and strategic alliances with industry, land managers, the community and other research organisations.

Controlling of expansive grass *Arrhenatherum elatius* and woody species by grazing management

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After abandonment, a species-rich secondary vegetation of dry grassland representing an important phenomenon with regard to nature conservation is degraded by an undesirable expansion of perennial herbs (particularly tall grass species) and woody species. Among herbs, *Arrhenatherum elatius* is one of the most expansive species representing plants of global importance due to its intensive spreading in the large areas of Europe and North America. It creates a compact grassland limiting prosperity of competitively weaker species. Reintroduced grazing is considered the most natural and effective method of rehabilitation and management of grassland. In the year 2000, a grazing management was introduced to maintain species diversity of dry grassland in the protected areas on the territory of Prague City. In the course of ten years, response of the expansive grass species *Arrhenatherum elatius* and woody species with the prevailing *Prunus spinosa* to period of grazing was monitored. Grazing in spring till the end of June had the biggest impact on the reduction of *Arrhenatherum elatius* and woody species. Grazing in the height of summer and in autumn did not reduce their cover. On the contrary, grazing in late summer could support prosperity of both *Arrhenatherum elatius* and woody species, including the prevailing *Prunus spinosa*.

**Acciones de Rescate y Conservación de Flora Silvestre, “Proyecto carretero Campos-Alameda-Punta Grande y ramal ferroviario por la margen norte del vaso II de la laguna de Cuyutlán, Manzanillo, Colima**

**Durán, Miriam; Fernando Gómez Santamaría, Edgar Armas Villegas, Sergio López Noriega, Norma Fernández Buces, Gilberto Centeno Mota**

Grupo SELOME S.A de C.V

Hasta hace unas pocas décadas, los proyectos de infraestructura no tomaban en consideración las condiciones ecológicas de la zona de influencia y los daños ambientales que se pudieran ocasionar al momento de su construcción y operación; con lo que se afectaron diversos ecosistemas en México. Hoy en día sabemos que los impactos ambientales se pueden prevenir, mitigar, restaurar y compensar, a garantizar la conservación, restauración y el uso sustentable de los recursos naturales. Claro ejemplo es El “Proyecto carretero Campos-Alameda-Punta Grande y ramal ferroviario por la margen norte del vaso II de la laguna de Cuyutlán, Manzanillo, Colima, México, en donde se efectuaron acciones de rescate, conservación y producción de flora nativa de los tres tipos de vegetación presentes en la zona del proyecto (Bosque Tropical subcaducifolio, Vegetación halófita costera y Manglar). Los procedimientos de rescate consideraron plantas vivas con cepellón, plantas vivas a raíz desnuda, estacas o esquejes y el rescate de frutos para obtención de semillas. A partir de ellos, la producción de plantas en un vivero rústico instalado en el sitio se realizó mediante métodos de propagación sexual y asexual. Como resultado, 16,329 plantas fueron rescatadas; 46,830 plantas fueron producidas en el vivero, para un total de 63,159 plantas de 32 especies conservadas en vivero. La conservación y propagación de especies propias de la región permite contar con suficiente material vegetal y ecológicamente apropiado, destinado a la reforestación y restauración de los sitios afectados, una vez que se concluyan las obras.
**Effects of landscape features over vegetation structure in restoration areas of Atlantic Forest, Brazil**

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Universidade Federal do Paraná

There are several factors that influence the success of ecological restoration and among them is the structure of the landscape around the restored area. In this work we evaluated the relationships between vegetation structure (tree abundance and species richness) and characteristics of the landscape (percentage of mature forest, young forest, degraded and humid areas) in restoration areas in Southern Brazil. We estimated the area of different habitats in three different radiuses (200, 500 and 1000 m) around the vegetation plot. The results showed that there is strong positive correlation between the percentage of mature forests and the abundance, basal area, and tree species richness in shorter distances of the vegetation plot (respectively, 200m: r=0.41, r=0.42, r=0.42; 500m: r=0.71, r=0.75, r=0.68, all p<0.001). No correlations were found at 1000m and between young forest, degraded and humid areas and vegetation structure. We concluded that habitat quality is an important factor determining resilience of the vegetation and the success of ecological restoration.

**Predicting restoration trajectories based on plant functional types and species composition**

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Tropical forests are among the most degraded and threatened ecosystems in the world. Any restoration efforts will probably not recover natural species composition of ancient forests but could improve many ecosystem functions and much of the original diversity components. Here we evaluate the predictive power of trajectories using Markov chain modeling described by a) species composition and b) functional types (PFTs). We used 20 areas of different ages since restoration (4-53 years) and four reference forests to sample natural regeneration (saplings >50cm height and <1cm DBH) in deciduous forests of southeastern Brazil. We sampled 139 species belonging to 42 families, where Fabaceae, Myrtaceae and Rutaceae represented the majority of richness. We used log-transformed data to increase importance of low-abundance species. We defined 10 PFTs by 4 traits (16 in total) that optimized the correlation between age and vegetation change (r=0.48, P=0.017). We clustered species based on this trait subset, which included shade tolerance, leaf hairiness, fruit size and presence of aril. We revealed trajectories by metric ordination followed by Markov fitting. Through time since restoration the number of species with larger fruits, greater shade tolerance and presence of aril increased whereas those with hairy leaves decreased. Markovicity (K) was considerably weaker for species (P(Knull≤K)=0.86) than for PFTs (P(Knull≤K)=0.18) trajectories, revealing a great potential to evaluate restoration success by PFTs. Therefore observing trajectories based on composition alone can limit the understanding of succession in recovering forests.
The status of ecological restoration of tropical forests in Latin America

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Despite the fact that Latin American (LA) countries individually lead the research efforts aimed at the restoration of local tropical forests, there are no attempts to coordinate or guide such work in the region. In this study we compiled the bibliographic database (Biological Abstracts, Cab Abstracts, Treedc and electronic databases Scielo and Science Direct) of published scientific papers dealing with ecological restoration of tropical forests in LA to verify the status of the art of the subject and to identify potential knowledge gaps. Of the total scientific papers (131), 53% were produced in Brazil and Mexico, followed by Costa Rica (20%). There was an increasing trend in the number of publications from 1992 to 2011, especially after 2000. Most of the restoration works were carried out in areas of rain forests (62%) that were previously disturbed by grazing (48%). The main strategy of restoration was spontaneous regeneration (49%) and limiting factors were related to seedling establishment (52%). The majority of the studies were sampling method (95%), in a period of 1 to 3 years (59%). The results showed that ecological restoration is still incipient in some LA countries and suggests that conservation of tropical forests depends on a coordinated and effective work of all countries in the region.

Revegetación de áreas impactadas por la actividad minera: Efecto del riego y agregado de compost sobre el establecimiento de plantas nativas de zonas áridas

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En el presente trabajo se realizó un ensayo de revegetación con 5 especies nativas de zonas áridas, Atriplex lampa, Larrea divaricata y Prosopis flexuosa, emplazadas en una cantera y en una localización minera al sur de la provincia de Mendoza, Argentina. Las variables evaluadas fueron: agregado de compost (5 dm3/0 dm3) y suministro de agua (5 litros/mes durante 6 meses; 5 litros por única vez). Luego de dos años de registros, se evaluó la supervivencia y el crecimiento de los plantines. En la cantera se observó una menor supervivencia (46%) que en la localización (77%) a causa, probablemente, de una mayor salinidad del suelo. Las especies que presentaron una mayor supervivencia fueron Hyalis argentea (88%) en la localización, y Larrea divaricata (65%) en la cantera. Mientras que las especies con menor supervivencia fueron, Prosopis flexuosa y Larrea divaricata (22%); lo que podría deberse al ataque de roedores. Tanto el agregado de compost como el riego no produjeron ningún efecto significativo sobre la supervivencia y el crecimiento de los plantines. En ambas plantaciones, Atriplex lampa presentó un mayor crecimiento vegetativo con respecto a las demás especies. En el presente ensayo, se podría decir que ni el agregado de compost ni el riego producen una mejora en el establecimiento, por lo que se debería investigar distintas frecuencias de riego en distintos períodos de tiempo para aumentar el establecimiento de plantines en programas de revegetación.

The role of traditional ecological knowledge in reforestation efforts in rural Maya Yucatán

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The Yucatan Peninsula has experienced drastic anthropogenic deforestation and biodiversity loss since early colonial times. Deforestation in seasonal dry tropical forests (SDTF) has had direct and indirect repercussions on Maya communities. This project was focused on the condition of biodiversity (measured by the plant resources) as well as the impacts on local community. Direct affects on the physical environment include a dramatic decrease in forested land while indirect affects include changing Maya perception, understanding, and conservation of forest environs. My research was conducted in two locations in the Yucatan Peninsula with dissimilar environmental degradation; the village of Ixil, Yucatan, Mexico and Reserva San Nicolas, a newly established biological preserve located near Cenotillo, Yucatan, an area that for the most part has been conserved with less human impact. I compared the loss of biodiversity from ongoing deforestation as well as the loss of bio-cultural diversity, as traditional farming and forest practice is lost. Research methods included interviews and surveys of the community, from young adults to elders who have witnessed drastic changes over time in local forest and solares (domestic gardens). In addition I collaborated with community members in the field to assess plant recognition in ten sample transects each 50X2 M, within an area of 0.1ha-1000m^2, which yielded a quantitative analysis of vegetation communities as well as a summary of local plant recognition knowledge.
Richness and abundance of natural regeneration of a riparian vegetation stretch in Pandeiros River (southeast Brazil) after a year of different recovery models implementation

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Universidade Estadual de Montes Claros

Riparian vegetation is of great importance for the conservation of rivers and these forests have been extensively altered. Natural regeneration promotes restoration, precluding the need to implement more costly techniques. This study aimed to evaluate the development of natural regeneration, through the analysis of richness and abundance of species, after a year of implementing recovery models, in an area impacted by cattle (Pandeiros River/Brazil). The regeneration monitoring was carried out from January 2010 to February 2011 in seven 1 ha plots, where the following models were established: seedlings planted in two distances rows (2 and 4 m) with the presence or absence of direct sowing (S), called T2, T2S, T4 and T4S; direct sowing (S); area treated with organic matter (E); and open area (AA). To evaluate the regeneration, 4m² subplots (74) were marked, where all recruited seedlings were evaluated. Abundance was recorded only for woody species. To compare species richness and abundance in different models, analysis of variance and Tukey test were made. We recorded 144 species and 1275 individuals. The abundance of woody plants (gl=6; F=12.2; P<0.05) and richness of herbaceous and woody individuals (gl=6; F=2.6; P<0.05) differed among models. The subplots with higher species richness were those of the AA model which differed from all other models, probably related to the greater number of herbaceous species recruited. The T4S model presented great recruitment of wood species, indicating efficiency in the restoration of these species.

The Gulf of Mexico Community-based restoration partnership: 10 years of coastal habitat restoration

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The Gulf of Mexico Community-based Restoration Partnership is a multi-year, regional partnership between between the NOAA Restoration Center, EPA Gulf of Mexico Program, and the Gulf of Mexico Foundation. Since 2002 the restoration program has funded citizen-driven habitat restoration projects benefitting living marine resources and fostering local stewardship throughout the Gulf and Caribbean. This poster will give an overview of the Gulf of Mexico Community-based Restoration Partnership (GCRP) and its successes over the life of the partnership. This will include highlighting selected projects and partners, as well as partnership metrics such as leveraged funds, community/volunteer contributions, acres restored and benefited, etc. In addition, the poster will show how GMF and the GCRP are trying to look beyond the Gulf of Mexico to our neighbors in the Caribbean Basin. We will highlight upcoming funding opportunities for community-based restoration projects and provide training information for proposal-writing and project development.

Methodologies for environmental restoration in post-mining site, monitoring, evaluation and management

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IBR Empreendimentos e Participações

The restoration of sand mining explored areas is a relative new reality and still needs standard monitoring and evaluation methods. The interventions derived from sand mining process bring a decrease on the biodiversity and also in natural regeneration potential. For this reason it is important to understand systematically all processes involved, looking forward to subsidizing local management for complementary actions of site enrichment and direct revegetation when needed. The area is located in the city of São José dos Campos, state of São Paulo, Brazil, on a deactivated mining facility that has had no extraction activity for the last 17 years. Qualitative mapping studies were made for forest evaluation and comparative methods used on abandoned areas for natural regeneration, enrichment and revegetation. Preliminary results show that the forest fragment has 55% pioneer species, 33% non-pioneer species and only 12% in identification process. The species Alchornea triplinervia and Guarea guidonia stood out as the ones with a higher level of importance and are present in most of the plots. The diversity inventory among the areas achieved 90 identified species, in 37 families, of those, 40 species are only in the forest fragment. Periodic follow-ups will provide a greater amount of information that will allow a detailed view of the restoration strategies applied.
Propagación, desarrollo inicial y manejo de cuatro especies leñosas nativas útiles para la restauración en sistemas ganaderos tropicales activos: Resultados preliminares

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Este trabajo busca caracterizar la propagación sexual, desarrollo inicial y manejo local de cuatro especies de árboles nativos. Estas especies se seleccionaron por su capacidad de mantener biodiversidad nativa, restaurar funciones del ecosistema natural y ser usadas por la población local, al reintroducirlas en sistemas ganaderos tropicales activos. El sitio de estudio está en Hueytamalco (Puebla, México), una región con alto grado de marginación y paisaje fragmentado, dominado por la ganadería. La vegetación remanente es una transición entre selva tropical y bosque montano. En un vivero local, se evaluó la tasa de emergencia y de establecimiento (dos meses después) de plántulas en relación a las semillas sembradas. Además se calculó la tasa de crecimiento en altura y en diámetro basal. Se realizaron entrevistas para reconocer el manejo de estas especies en la zona. Los resultados preliminares muestran dos especies con buenas tasas de emergencia y de rápido crecimiento, en las que al menos 10% de las semillas se establecen como plántulas: Saurauia scabrida “ixlahuite”, de uso forrajero y Ficus turrialbana “higuerrilla”, usado como árbol de sombra. Dendropanax arboreus “temalcauite”, usado para leña, de rápido crecimiento, pero su tasa de emergencia y de establecimiento depende del árbol del que proceden las semillas. Matudaea trinervia “quebracho”, árbol muy apreciado por su leña y madera, de lento crecimiento. La emergencia fue de 10-50%, pero se establecieron menos del 1% de las plántulas.

Site prioritization for Atlantic Forest restoration: A standard protocol

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Site selection for conservation and restoration of habitat is challenging worldwide, especially in tropical regions where habitat loss and fragmentation highly threatens the biodiversity. We designed a replicable protocol for site prioritization towards ecological restoration in the Brazilian Atlantic Forest. Only c.a. 12% of original forests remains in this hotspot of biodiversity, which makes ecological restoration vital in the region. Brazilian Restoration Act proposed to restore 15 million of ha on next two decades, and site prioritization becomes a main task in order to optimize the application of the always limited funding. The proposed protocol is applicable at local and regional scales, and includes both Brazilian legislation aspects, as well as a set of ecologically scaled landscape metrics. Furthermore it is flexible, allowing calibration considering: (1) the movement abilities and the use of functionally connected habitats of a focal/umbrella species, (2) ecological processes and related assumptions and/or (3) logistical possibilities. We conducted a study case in the Atlantic Plateau of São Paulo, an area that was formerly covered by forests, which today is extremely reduced and fragmented. The input data are derived from remote sensing and the proposed protocol integrates a set of GIS tools available on both commercial and open source softwares. Firstly we characterized the Plateau and its subwatersheds (SWS), and identified all the potential sites for restoration within the region. Then we ranked the importance of each SWS in regional scale and of habitat patches in local scale. Next steps of this study include the inclusion of other set of information, such as geomorphometry, as well as the implementation of the protocol as a toolbox for ArcGIS software.

Control de erosión mediante el empleo de técnicas de bioingeniería en el parque ecológico “Cubitos”, en el estado de Hidalgo, México

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Hay suelos de México muy proclives a la erosión; lo que provoca perdida de materia orgánica y decremento de la capacidad de intercambio iónico alterando sus condiciones físicas y químicas, dificultando la supervivencia de la vegetación. Este trabajo se realizó con el fin de controlar la erosión que presenta el Parque Ecológico Cubitos localizado en el suroeste de la ciudad de Pachuca, en el Estado de Hidalgo, México, 20°, 07” y 21” Norte, 98°, 44” y 09” Oeste, es una área natural protegida, para recuperar el suelo y la cubierta vegetal. En el Parque se ubican tres zonas de estudio con diferente grado de erosión para aplicar técnicas de bioingeniería como: barreras físicas de rocas, zanjas de infiltración, geomallas orgánicas (yute), trincheras, enramados, diques con plantas, posaderos artificiales, acolchados. Se realizó el análisis de suelo de las tres áreas y se encontró que la concentración de Nitrógeno (N), Fósforo (P) y Potasio (K) son bajos de acuerdo a la NOM-021 RECNA-2000; en dos años se han recuperado cinco centímetros de suelo; las especies transplantadas son nativas, están vivas y han crecido en promedio seis centímetros;
en los acolchados se han encontrado excretas con semillas y algunas de ellas han germinado y la concentración de N,P,K aumentó. Se puede concluir que el empleo de estas técnicas a mediano plazo permite la recuperación del suelo y la cubierta vegetal.

**Silvicultura, rehabilitación y comunidades locales: Puntos de encuentro en robledales de alta montaña Boyacá, Santander-Colombia**

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Universidad Distrital “Francisco José de Caldas”

*Quercus humboldtii* es una especie característica de los Andes colombianos que se desarrolla asociada a numerosas especies como *Billia rosea, Alchornea grandiflora* y *Virola macrocarpa*. Con el objeto de plantear estrategias de rehabilitación y manejo con la participación de las comunidades locales en los bosques de roble de los municipios Belén y Encino (cordillera oriental colombiana), se identificaron los principales aspectos biofísicos y socioculturales que determinan la distribución actual de las poblaciones de *Q. humboldtii*, las cuales se fueron caracterizadas a través de levantamientos ecológicos y silviculturales (DAP ≥ 2.5 cm). Se encontró que la distribución de los robledales está asociada a criterios geomorfológicos y socioculturales. Con los resultados del análisis ecológico y silvicultural se propuso: podas de formación en el estrato arbóreo para permitir el ingreso de luz al sotobosque y fomentar el desarrollo de la regeneración natural; liberaciones y cortas de sanidad en las categorías diamétricas donde estructuralmente hay excesos frente a la distribución característica de los bosques tropicales; enriquecimiento con especies de las familias *Lauraceae, Magnoliaceae, Clusiaceae, Meliaceae* y *Podocarpaceae*, ausentes por efecto de la entresaca a la cual han estado sometidos los bosques. Con la implementación de estos tratamientos silviculturales se espera mejorar la integridad ecológica de los ecosistemas, contribuir a la restauración y rehabilitación de estos bosques, y aportar a la satisfacción de la demanda por recursos forestales de la comunidad.

**Evaluación del Capital Natural de parques nacionales en el DF, utilizando grupos megadiversos**

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El estudio de áreas verdes en áreas urbanas, es indispensable para conocer los efectos antropogénicos sobre las mismas, ya que sin duda la dinámica y estructura de las comunidades que ahí habitan se ven afectadas. Tal situación requiere de respuestas en el corto plazo, por ello es indispensable realizarlo con organismos claves y muy diversos, como es el caso de las arácnidos. Estos organismos son indicadores valorosos en la calidad ambiental, debido en gran parte a su gran riqueza, abundancia y la alta capacidad de ocupar diferentes microhábitats. El estudio abarcará una de las zonas más perturbadas (Cerro de la estrella) y una de las zonas menos perturbadas (Parque Ajusco) al oriente y sur de DF respectivamente. Hasta el momento se ha realizado un estudio piloto de cuatro meses en la primera localidad, monitoreando poblaciones de alacranes, los cuales, no se ven afectados por los asentamientos urbanos, el ambiente rocoso que se ha ido incrementando con el tiempo propicia el hábitat ideal para establecerse.

**Restoration of floodplain lakes as components of drainage systems in agricultural areas**

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The broad, flat open floodplains on the valley floors of the meandering lowland rivers are subject to periodic flooding and their rich alluvial deposits support fertile pastures and meadows. A part of the floodplain landscape is a distinctive pattern of meander loops and oxbow lakes. In case of hydrotechnical alterations, when river straightening followed land reclamation, newly formed cut-offs, not the river itself, became direct recipients for the nutrient-rich water from reclaimed areas. In agricultural landscapes, oxbow lakes may function as very effective biogeochemical filters contributing to sediment trapping, nutrient removal and river pollution prevention. Hydrochemical studies of 21 oxbow lakes conducted along meandering sections of three river channels in northern Poland (Drwęca, Łyna, Stuńia rivers), showed that the input of nutrients with reclamation ditches from arable lands and grasslands is one of the most important factors stimulating the development of eutrophication. The most effective traps for nutrients are oxbows disconnected to the river and supplied with ditch outflows. The degradation of disconnected ecosystems is much faster than those connected to the river. They undergo accelerated hypertrophy, overgrowth and disappearance. The group of cut-offs require comprehensive restoration methods to hold up the loss of ecological potential. We recommend that restoration should focus on combining methods linking reconnecting isolated cut-off channel habitats and maintenance of biofilters at the ditch outlets. Instream habitat enhancement should be employed after
restoring natural processes. Moreover, comprehensive physical and biological evaluations of most oxbow restoration methods are needed.

**Restoring the Gardens at Thlchess**

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Chatham Islands, Thlchess, territory of the Songhees First Nation, are part of a small archipelago in the Salish Sea, off southeastern Vancouver Island. These islands comprise nationally endangered Garry oak ecosystems, supporting a wide diversity of habitats for plant and wildlife communities. Thlchess, used to be a self-sustaining village site for the Songhees, with traditional gardens and orchards. Uninhabited for over 50 years now, Thlchess has entered in a process of rapid environmental change. Songhees elder Sellemah, who was born and raised there, longs to see traditional gardens and orchards restored, as well as her people’s relationship with their environment, for healthier and more sustainable ways of life. My research honours this vision by combining qualitative, quantitative and participatory approaches to generate baselines for ethnoecological restoration for garden- and orchard-associated ecosystems in Chatham Islands, including the (1) generation of an ecological and cultural profile of garden and orchard remnants, through a combination of ecological examinations and documentation of traditional knowledge associated with the use and cultural significance of plants and practices, (2) generation of historical reference for restoration through archival and historical research on socioeconomic and ecological aspects of the islands, (3) investigation of community perceptions and relationship with Thlchess, as well as pathways for ethnoecological restoration. Ultimately, this research aims to provide assistance in the restoration of ecological and cultural features in Chatham Islands and within the Songhees First Nation, revitalizing traditional ecological knowledge on the landscape and reversing trends of biodiversity and cultural loss.

**Elaboración del Documento de Diseño de Proyecto (PDD) de un proyecto a pequeña escala de reforestación de manglares en Marismas Nacionales, Nayarit, México; dentro del Mecanismo de Desarrollo Limpio**

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Comisión Nacional Forestal, Mexico

Se presenta la metodología CDM – SSC-AR-PDD: PROJECT DESIGN DOCUMENT FORM for SMALL-SCALE afforestation and reforestation project activities específicamente la del tipo “Implemented on Wetlands” utilizada para el diseño de un proyecto de reforestación de 56.9 ha de manglar en el sitio Ramsar Marismas Nacionales, Nayarit, México. El objetivo principal del proyecto es restaurar las condiciones naturales del manglar y no incluye ningún tipo de actividad de extracción o explotación maderera. El proyecto diseñado estima la captura aproximada de 1.86 tons CO2 por año, con un periodo de vigencia para la venta de bonos de carbono de 20 años. El proyecto está ubicado en una comunidad de 30 familias, con índices de alta marginalidad y bajos ingresos, que se han visto directamente afectados por la disminución de las capturas pesqueras, echo que atribuyen directamente a la degradación del ecosistema de manglar. Se presenta la metodología utilizada para la selección de áreas de trabajo de acuerdo a los criterios de elegibilidad, “Procedimientos para demostrar la elegibilidad de tierras para actividades de forestación y reforestación del MDL”, aprobado por el Consejo Ejecutivo. Se describe el proceso de análisis histórico geográfico realizado con imágenes satelitales de Landsat 1986 y SPOT 2009; así como la metodología de verificación en campo. El diseño de proyecto establece una línea base en cero, con árboles muertos y un incipiente estrato herbáceo (Salicornia sp). El proyecto contempla la participación de dependencias públicas federales (CONAFOR), especialistas e investigadores nacionales y la participación de los pobladores.

**Impacto de la producción de carbón vegetal en suelo de bosque de Encino**

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Universidad de Guanajuato

El bosque de *Quercus* sp. pl. en Santa Rosa, Gto., es considerado como una de las regiones prioritarias para estudio y conservación del país (CONABIO), por su biodiversidad. Su cuenca hidrológica tiene un papel importante en la regulación del ciclo hidrológico en la zona agrícola del estado. Las principales actividades forestales son extracción de madera y su procesamiento hasta carbón vegetal, en sitios denominados “carboneras”. Las altas temperaturas generadas durante la producción del carbón ocasionan una mortalidad selectiva de la comunidad microbiana y pérdida de nitrógeno. En este trabajo se tomaron muestras de suelo tres sitios: carbonera, adyacente a carbonera y conservado. Con el DNA de suelo, se amplificaron por PCR los genes nitritoreductasa, nitrogenasa,
amoniomonooxigenasa, para evaluar la diversidad funcional de las comunidades microbianas involucradas en el ciclo del nitrógeno. La electroforesis DGGE, es una herramienta útil para determinar directamente la ecología y diversidad genética de una población microbiana compleja como es en el caso del DNA total de muestras de suelo. Se encontró: una disminución en el índice de diversidad de Shannon en la carbonera, los dendogramas mostraron agrupaciones diferentes entre los sitios. El objetivo principal de este trabajo fue mostrar como la producción de carbón vegetal afecta la funcionalidad y diversidad de la comunidad microbiana del suelo del bosque. Las prácticas forestales invariablemente cambian las propiedades del suelo y los procesos que en suelo se realizan (ciclo del N), con un efecto negativo.

**Evaluación del ecosistema ripario en ríos de la Reserva de la Biosfera de la Mariposa Monarca**

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Los ecosistemas riparios cumplen con diversos servicios ecosistémicos como el control de la temperatura y la regulación de la calidad del agua y la retención de sedimentos, entre otros. Este último ayuda a mitigar en parte la eutrofización de los cuerpos de agua. Sin embargo actividades como la deforestación, la agricultura y el pastoreo, han acrecentado la erosión, lo que ocasiona entre otras cosas, un aumento en la tasa de sedimentos transportados por los cauces de los ríos a largo de las cuencas, acelerando los procesos de eutrofización y degradación de la calidad del agua. Ante esto resulta necesario un conocimiento integrado acerca del estado de salud y de los servicios ecosistémicos de los ecosistemas riparios, con fines en la restauración y mejores manejos de los mismos. Por lo que el objetivo del presente estudio consiste en la evaluación del ecosistema ripario a lo largo de ríos ubicados en la Reserva de la Biosfera de la Mariposa Monarca (Michoacán). Para la evaluación de la salud del ecosistema ripario, se empleará un protocolo que contemple diferentes aspectos del ecosistema y que sea flexible en los criterios a evaluar. Mientras que en la evaluación de la retención de sedimentos, se evaluará la sedimentación lateral mediante clavos graduados. El estudio de los ecosistemas riparios repercutirá en la integridad ecológica y en la capacidad de estos de proveer servicios ecosistémicos.

**Humedad y temperatura, barreras para el establecimiento de Pinus montezumae y restauración ecológica en el padregal del volcán Paricutín**

Gómez Romero, Mariela; Enrique Flores Torres, José Arnulfo Blanco García, Roberto A. Lindig Cisneros
UMSNH-UNAM

El estudio fue realizado en los depósitos de lava volcánica, provocados por la erupción del volcán Paricutín en Michoacán, México (1943-1952), dejando severos daños a las comunidades biológicas. El interés radica en acelerar el establecimiento de plantas en suelos desprovistos de vegetación. El experimento se estableció en dos etapas, la primera en campo, en los derrames de lava conocido como pedregal, la segunda en laboratorio; se trasplantaron individuos de *Pinus montezumae* de 18 meses de edad. Se evaluaron micrositios y tratamientos de acolchado con paja con la finalidad de amortiguar las altas temperaturas (5-45°C). Las variables evaluadas fueron supervivencia, altura y diámetro durante temporada de lluvias y secas. El acolchado favorece la supervivencia en relación al efecto de micrositios protegidos medios y expuestos. Los pinos presentaron un mayor desarrollo en micrositio expuesto y los protegidos presentaron desempeño menor, finalmente murieron en su totalidad. El trabajo de laboratorio fue enfocado para determinar las causas de mortalidad de los pinos en campo, por lo cual se germinaron pinos de la misma especie en condiciones de estrés hídrico y térmico, los pinos fueron sometidos en diferentes tiempos a una temperatura de 42°C en una cámara de calor. Tomando en cuenta las temperaturas registradas en campo. Los resultados demostraron que la variación de la temperatura, pero sobre todo, la falta de humedad fueron determinantes, lo que explica la mortalidad en el experimento de campo. Por lo tanto, una barrera para la restauración del sitio que explica el proceso lento de sucesión primaria del sitio.

**Germinación y propagación de Senna septemtrinalis con fines de restauración ecológica**

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UMSNH-UNAM

El estudio busca contribuir mediante generación de información sobre requerimientos pregerminativos de semillas de *Senna septemtrionalis*, así como condiciones de sustrato para su propagación en condiciones de invernadero y establecimiento en campo (Área Natural Protegida, Cerro Punhuato en Morelia, Michoacán, México). La implementación de tratamientos pregerminativos deben ser tomados en cuenta con la elección de especies con potencial para ser utilizadas en proyectos de restauración ecológica. El proyecto plantea experimentos aplicados con
la especie Senna septemtrionalis (Fabaceae), con la finalidad de encontrar las condiciones óptimas para la germinación, propagación y establecimiento. Se utilizaron tratamientos de escarificación química por medio de ácido sulfúrico concentrado por 15, 25, 35, 45 y 60 minutos, además de escarificación mecánica mediante lijado manual y un control. El tratamiento que presentó mayor porcentaje de germinación fue 45 minutos con porcentajes de 90%. Se realizó un experimento mediante prueba de sustratos, en éste se emplearon cinco tratamientos con distintas cantidades de arena y materia orgánica (sustrato comercial, Creci-root®). Tratamientos: 100% arena, arena–creci-root 1:2, 1:1, 2:1 y 100% creci-root. Se encontró que el tratamiento 1:2, fue el que presentó valores mayores e altura, número de hojas y diámetro. Los resultados sugieren que la presencia en mayor cantidad de materia orgánica y menor en arena, favorece el desempeño de las plantas. Adicionalmente se encontró que para su establecimiento, el uso de nodrizas presentes en el sitio puede representar una alternativa viable para incrementar supervivencia y desempeño, y por tanto, lograr mejores resultados en el proceso de restauración.

**Desempeño del tandem *Pinus pseudostrobus-Eysenhardtia polystachya* en acrísoles mediado por hongos micorrízicos**

Gómez Romero, Mariela; Roberto A. Lindig Cisneros, H. Javier A. Villegas
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En la actualidad nuestro país cuenta con una extensión considerable de su territorio con graves problemas de erosión, debido principalmente a la falta de una cobertura vegetal como resultado de la deforestación. Además, la consecuente degradación del suelo causa que el fósforo sea muy limitante, por lo que se requiere de investigación y estudios que contribuyan a lograr el establecimiento de especies vegetales y de esta forma, contrarrestar los daños causados por la degradación. Para contribuir con este fin, se propuso estudiar la respuesta de especies nativas fijadoras de nitrógeno y especies arbóreas, para lo cual, se estableció un experimento de campo en tándem *Pinus pseudostrobus-Eysenhardtia polystachya* y su respuesta a la inoculación de hongos micorrízicos (ectomicorrízicos y endomicorrízicos) mediante un diseño ortogonal de 8 tratamientos, con 19 réplicas, para evaluar la supervivencia y desempeño de las especies leñosas, mediante la medición de la altura, el diámetro y la cobertura de ambas especies. El experimento se realizó in situ en suelos intemperizados (Atécuaro Mich.), con la finalidad de conocer el desempeño del tándem en condiciones naturales. Se sabe que el restablecimiento de la cobertura vegetal es de vital importancia para revertir los daños causados por erosión. En un contexto general, esto reconvertiría zonas afectadas por erosión a sistemas productivos a largo plazo. Los resultados muestran que los pinos inoculados con hongos micorrízicos presentan valores significativamente mayores de supervivencia. La presencia de las leguminosas inoculadas con hongos micorrízicos, incrementa la sobrevivencia y desempeño de los pinos. El estudio de plantas con potencial para formar asociaciones simbióticas puede contribuir a mejorar las estrategias de restauración.

**Maricultura del callo de hacha, *Atrina maura*, para su repoblación en Navolato, Sinaloa, México**

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IPN-CIIDIR-SINALOA

Las pinas (*Moluscos bivalvos*) sujetos a protección especial presentan una alternativa para la administración del pueblo mexicano debido a su alto valor nutritivo, digestividad, consumo directo, resistencia para su manejo y transporte. Se estudió el crecimiento de *Atrina maura* durante 15 meses de cultivo en la ensenada La Palmita, Navolato, Sinaloa. El experimento se realizó utilizando el sistema de canastas en suspensión para los primeros cuatro meses de cultivo ajustando la densidad a 200 callos/canasta, y la siembra en parques de arena durante los once meses restantes a una densidad de 18 callos/m². Los juveniles (16.19 ± 6.66 mm de longitud total y 0.3 ± 0.16 g de peso total de promedio inicial) se obtuvieron de un laboratorio comercial. Los parámetros físicos (oxígeno disuelto, salinidad, temperatura y pH) y químicos (clorofila “a”) fueron obtenidos cada 15 días y cada mes respectivamente, mientras que 50 bivalvos seleccionados al azar fueron medidos y pesados mensualmente. Al final del cultivo se presentó un peso promedio (284.26 ± 54.45 g, P > 0.05) y una supervivencia del 53.69%. Los resultados indican que es posible cultivar *A. maura* a densidades mayores de 200/canasta-18/m², contribuyendo con el aumento de las poblaciones, que por haber estado expuestas a una excesiva explotación, se hallan en peligro de extinción o bajo protección especial.
Las acuiculturas son prácticas que han crecido aceleradamente por el incremento en la demanda de alimentos a nivel mundial, una de las especies alternativas de cultivo es la ostra de Cortez Crassostrea corteziensis, la cual posee un alto potencial acuícola, no solo en México sino también de Centroamérica, y que ha sufrido una severa reducción en sus poblaciones durante los últimos años. En el presente estudio se evaluó el crecimiento y la supervivencia del ostión de Cortez y las variables de temperatura, oxígeno disuelto, salinidad, pH, profundidad, transparencia y clorofila "a", en el estero La Piedra, Guasave, Sinaloa durante un ciclo de cultivo. La siembra se realizó en Enero del 2010. Se mantuvieron 3,000 semillas en bolsas de malla y posteriormente fueron colocadas en canastas Nestier sujetas a una línea madre, al mes y medio de cultivo se realizó el aclarado de las ostras, colocándose a una densidad de 42 organismos por canasta. Como resultados encontramos que la temperatura del agua (32.5°C) y la salinidad (36.5 a 39.5 g L⁻¹), fueron los factores que estuvieron por encima del límite de tolerancia de C. corteziensis. Respecto al crecimiento C. corteziensis este alcanzó una talla 82.10 mm de altura con una supervivencia del 97% al finalizar el ciclo de cultivo. La maricultura representa una opción para la recuperación del stock de esta especie que es un importante recurso pesquero para el estado de Sinaloa.

**Estructura de la comunidad vegetal y composición faunística en un pedregal sujeto a adición de rocas volcánicas y otras acciones de restauración: un estudio de cinco años**

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UNAM

Se analizó la recuperación de la comunidad vegetal y la fauna en una parcela de 0.31 ha dentro de la Reserva del Pedregal de San Ángel (D.F., México), sobre la cual se intentó construir un estacionamiento. Para restaurar el sitio, en 2005, se extrajo el material de relleno y se adicionó roca basáltica. Se ha extraído de la zona plantas exóticas y malezoides, así como material de relleno no consolidado. Se comparó la parcela sujeta a restauración (A11) con una zona conservada de referencia (ZCR). En A11 domina la planta exótica Pennisetum clandestinum; pero desde 2008 dominan las plantas nativas no arvenses. El chapulín Sphenarium purpurascens fue incrementando su densidad de modo que desde 2008, A11 registra mayores densidades que ZCR. La araña Neoscona oaxacensis no ha presentado diferencias de densidad entre sitios. Peromyscus gratus tuvo una densidad de 0.30 ind/trampa en 2006-2007 y Mus musculus estuvo presente con densidades de 0.05 ind/trampa. Durante 2009-2010 P. gratus registró 0.29 ind/trampa y ya no se ha registrado M. musculus. Se registraron 64 y 62 especies de aves; 8 y 7 especies de mamíferos y 4 y 3 especies de anfibios y reptiles en A11 y ZCR, respectivamente. La adición de basalto crea microhábitats para la fauna y el control de plantas exóticas y malezoides ha permitido un aumento de plantas nativas no arvenses.

**Determining priority sites for riparian rehabilitation in an urban-rural gradient: The Matanza-Riachuelo watershed, Buenos Aires, Argentina**

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Worldwide natural resources suffer severe and continuous processes of degradation due to intensive exploitation and unsustainable development given current human consumption habits and population growth. This trend may be reversed by means of ecosystem restoration and protection of natural remnants at the watershed scale. However, setting priorities is necessary, whenever resources are not sufficient to restore or protect all sites simultaneously, and especially when most of the landscape has been transformed to anthropogenic uses. Under this scenario, we investigated the potential for different types of management of all riparian zones (530 km of riversides) in one of the most contaminated watersheds in the world: the Matanza-Riachuelo. We processed a 2010 Landsat satellite image and used spatially explicit models in a GIS to quantify areas with varying potentialities considering the current land use and the threats they represent. We estimated that 12% of riparian areas have potential for conservation (natural remnants), 23% can be managed following aesthetic or recreational criteria (negligible restoration), whereas 65% can be subject to different rehabilitation techniques (removal of embankments, re-vegetation with native species, control of exotic plants). According to their level of degradation and degree of area/connectivity attributes, the latter were
assigned to three categories of priority: high (20%), medium (27%) and low (18%). In addition, this characterization enabled us to prioritize 23 sub-basins. We discuss the benefits of these results as a planning tool for the decision making of 15 municipal authorities responsible for the watershed management.

**Uso de residuos de la extracción de celulosa como alternativa para el desarrollo de especies arbóreas en un suelo degradado**

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Universidade Estadual Paulista

En este trabajo se ensayó la eficacia de un compuesto orgánico que se obtiene como residuo de la extracción de la celulosa, en el desarrollo de dos especies arbóreas sobre un suelo degradado. El experimento se llevó a cabo en Selvíria-MS, Brasil. El diseño experimental, en bloques al azar, consistía en parcelas subdivididas con cinco tratamientos y cuatro repeticiones. En las parcelas principales se plantó Eucalyptus urograndis y Mabea fistulifera y en las subparcelas se ensayaron los tratamientos: D0 (sin fertilización), DAM (fertilización mineral según los requerimientos del cultivo), DNC (fertilización con compuesto orgánico según los requerimientos del cultivo - 10 t/ha), D15 y D20 (15 t/ha y 20 t/ha de compuesto). Se evaluó la altura (ALT), el diámetro (DAS), el diámetro de la copa (DC) y la supervivencia (SUP) tras uno año de plantación. En ambos ensayos, las mayores alturas se observaron en el tratamiento DAM, significativamente diferentes de los demás. En la plantación de Eucalyptus el promedio de DAS en el tratamiento D0 fue menor que en los otros tratamientos, DC y SUP fueron significativamente mayores en los tratamientos DAM y DNC. En general se aprecia una tendencia a obtener valores más elevados en los tratamientos DNC y D15. Se concluye que la respuesta de Eucalyptus al compuesto fue más sensible, pero es necesario necesita un periodo más largo de la evaluación.

**Experiencias silviculturales en Venezuela y su valor para la restauración del bosque seco tropical**

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Los bosques secos tropicales representan uno de los ecosistemas más amenazados debido a presión por cambio de uso. En el caso venezolano, ha sido particularmente evidente en las Selvas alisias de los Llanos Colombo-Venezolanos, que han experimentado una disminución cercana al 90% de su superficie original. Esta situación hace necesario evaluar experiencias que permitan orientar estrategias de recuperación y restauración. Desde los años 60s, la Universidad de Los Andes ha venido desarrollado un programa de investigación silvicultural en el Bosque Universitario El Caimital, estado Barinas. Diversos ensayos fueron establecidos con la finalidad de evaluar respuesta de los ecosistemas al aprovechamiento de madera y posteriores tratamientos silviculturales. Se incluyó herramientas de regeneración natural dirigida (RDN) y recientemente plantaciones en fajas de enriquecimiento (EF) con diferentes especies. Evaluaciones recientes muestran como, aún cuando el objetivo inicial fue el establecimiento de especies forestales comerciales, se ha logrado la recuperación del ecosistema en su diversidad y estructura. Un aumento considerable en la regeneración de especies heliófitas pioneras y heliófitas durables fue encontrado durante las fases iniciales del tratamiento de RND. Una adecuada selección de especies y sistemático mantenimiento indica prometedores resultados en el segundo tratamiento. Se aprecia el restablecimiento de especies de diferentes gremios ecológicos comunes del bosque menos perturbado. El monitoreo de estos ensayos ha permitido identificar especies con potencial para el establecimiento de programas de restauración ecológica de estos ecosistemas altamente amenazados.

**Sistemas de información geográfica como herramienta de gestión de la restauración ecológica en áreas de cultivo de cacao**

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El Proyecto CAMBIOS (Cacaocultura en Ambientes Biodiversos para la Sustentabilidad) tiene como objetivo la recuperación de la diversidad biológica en áreas de producción de cacao criollo mediante diferentes estrategias de restauración ecológica. Este proyecto se lleva a cabo en una Finca de 188 ha ubicada en el Sur del lago de Maracaibo en Venezuela. Para dirigir las actividades de restauración y otros componentes del proyecto se ha realizado una base de datos geográfica mediante programas SIG, que incluye los aspectos físicos del área de estudio, infraestructura, red de reservas de biodiversidad, y además los aspectos relacionados con el manejo agronómico de la Finca. Esta base de datos ha permitido dirigir las estrategias de restauración en la distribución y establecimiento de microcorredores,
Selección y ubicación de las áreas de monitoreo y seguimiento del avance del proyecto. En la fase actual del proyecto esta herramienta permitirá analizar los efectos espaciales de la restauración sobre el cultivo y así identificar los beneficios del avance de la restauración ecológica para el cacao. Los sistemas de información geográfica son una herramienta de gran utilidad en el manejo y validación de proyectos de restauración ecológica sobre todo cuando se combina con la producción agrícola.

**Estatus de conservación de Sesuvium edmonstonei Hook. f. (Aizoaceae)**

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*Sesuvium edmonstonei* Hook. f. es una especie característica de zonas semiáridas costeras del trópico Suramericano. Es señalada como endémica de las Islas Galápagos (Ecuador), no obstante, ha sido citada en estudios recientes como parte de la comunidad costera en ciertas localidades de Venezuela, Colombia y Curazao. A fin de generar información de base sobre esta especie y definir su posible estatus de amenaza, se estudiaron algunos aspectos biológicos y poblacionales, mediante la descripción morfológica (enunciando todas las fases de su desarrollo), evaluación de los niveles de aborto y eficiencia reproductiva, así como algunos componentes poblacionales y el establecimiento de su distribución geográfica. Finalmente se elaboró una ficha resumen con la información necesaria para la definición de su estatus de amenaza. *S. edmonstonei* es una hierba perenne, de porte rastrero, tallos estoloníferos, hojas simples, opuestas, suculentas, sin nervación visible; flor axilar simple, tepalos con apéndices subterminales dorsales; numerosos estambres; ovario con óvulos numerosos, anatómicos; fruto tipo pixidio. Se registró un 30,84% de óvulos abortados y 6,22% de aborto de semillas; la eficiencia reproductiva natural fue del 80,48%. En cápsulas de Petri presentaron porcentajes de germinación desde 38% a 92%. Tomando en cuenta los valores de extensión de la presencia y área de ocupación obtenidos, se estableció para *S. edmonstonei* la calificación de Vulnerable, conforme con los criterios de la UICN.

**Disturbance-induced legacies and the potential for restoring coastal pine savannas**

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Pine savannas are among the most diverse ecosystems in North America and provide critical habitat for many species, but occupy only <3% of their original extent of >25 million ha. Coastal pine savannas are also vulnerable to anticipated effects of global climate change. Models of climate change predict rapid sea-level rise along the northern Gulf of Mexico and more intense hurricanes. Restoration of pine savannas is needed, but the effects of climate change on restored, as well as remnant communities, are unknown. This research aims to compare resiliency of remnant and restored plant communities to simulated hurricane disturbance. We hypothesize that 1) diversity and biomass of native, target species will decrease following experimental storm surge, and restored plots will follow a different compositional trajectory due to invasion by non-target species, and 2) soil chemistry between sites will differ, but intact soils in reference plots will favor growth of target species compared to that of degraded soils in the restoration plots. We compare community composition and soil properties between remnant and restored sites experiencing experimental storm surge. Preliminary soil analysis indicates higher soil water conductivity in restoration sites, suggesting legacies from previous storms and anthropogenic exploitation. Reference sites have higher moisture content characteristic of native pine savanna soils. As climate change alters disturbance regimes which shape coastal ecosystems, it will be necessary to assess structure and function of remnant and potentially novel plant communities and their capacity for adaptation.

**Landscape analysis to establish conciliatory strategies between forest production, biodiversity conservation and ecosystem restoration in the Campos and Malezales ecoregion, Argentina**

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Universidad Maimónides/Fundación de Historia Natural Félix de Azara

Searching for answers to certain questions –such as what is the minimum area to conserve or restore natural remnants embedded in production systems matrices, where and how to transform them, which are the critical and optimal levels and the thresholds of different forms of land use and which are the lateral flows between different landscape elements– becomes the goal when we set out to conserve or restore landscape. The “Campos and Malezales” ecoregion, located in Mesopotamia, Argentina, still retains a matrix of semi-natural grasslands under extensive livestock farming. However, since the mid-90’s landscape configuration has been changing rapidly by an advancing agroforestry frontier. We present the progress made to date to answer the above mentioned questions. Through the
calculation of landscape metrics as indicators of connectivity, heterogeneity, complexity, naturalness and diversity, we developed a patch-corridor-matrix model. We selected key forestry cores to define landscape configuration that maximizes connectivity restoration and the consequent reduction of natural remnants fragmentation. In addition, needs of regional-scale restoration were also identified, providing the basis for the environmental planning of the area. Given the inevitable movement of this eco-region towards increased agroforestry, landscape analysis is the best strategy for planning multifunctional landscapes that articulate productive options with biodiversity conservation and environmental recovery.

**Traits differences between invasive and noninvasive plants: The role of two forms of plasticity in plant invasions**

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Sun Yat-Sen University/Ludong University

Phenotypic plasticity has been recognized in Group two forms, morphological and physiological plasticity, have different mechanisms, resulting in different resource costs. The costs of physiological plasticity are lower and a response can be much more rapidly implemented than for morphological plasticity. In this study, we compared the responses of co-occurring phylogenetically-related invasive and noninvasive species in south China in response to variation in light availability, which is one of the most important limiting resources for plant growth in subtropical and tropical forests. We test the hypothesis that invasive species could exhibit higher physiological plasticity than noninvasive species, prompting their invasion success. Invasive species did not have a higher specific leaf area (SLA) than noninvasive ones in the same light conditions. Across treatments, both invasive species and noninvasive ones studied exhibited high morphological plasticity, while it appeared that the invasive species showed a substantially greater ability to adjust their physiological plasticity as compared to noninvasive ones. Aside, we found that the photosynthetic nitrogen use efficiency (PNUE) of invasive species is not always higher than noninvasive ones, particularly in low-resource habitats, which indicates that the use of ratios such as the PNUE should be treated cautiously. My data support the idea that invasive species do not have fundamentally different carbon capture strategies from noninvasive species, and high physiological plasticity with low costs is often a key component in facilitating plant invasions.

**Registro Nacional de Árboles Majestuosos de México como iniciativa de conservación del patrimonio natural**

Jiménez Cruz, Carmen del Rocío; Atzin Elihu Calvillo Arriola, Alicia Chacalo Hilú, Ernesto Herrera Guerra

Reforestamos México A. C.

México es uno de los 15 países del mundo con mayor extensión forestal, en su territorio se alberga cerca del 20% de su biodiversidad mundial; de las cerca de 20,000 especies de plantas vasculares el 10% son árboles. La relación entre el hombre y la naturaleza ha existido por un largo tiempo y es reflejada en la preservación de especies como iconos de nuestros pueblos. Ante la necesidad de generar un inventario que colectara información acerca de los árboles considerados como importantes en México, nacen como iniciativa de Reforestamos México A. C. dos proyectos: El concurso bienal de fotografía Centinelas del Tiempo y el Registro Nacional de Árboles Majestuosos de México (RNAMM); los cuales compilan documentación dendrológica y social de importancia. Desde sus inicios en 2007, el primero ha colectado alrededor de 2060 fotos pertenecientes a 1600 fotógrafos; así mismo algunos de los principales resultados del RNAMM han sido incluir a 200 individuos pertenecientes a 24 familias, 35 géneros y 49 especies, así como una iniciativa de protección a nivel estatal y dos municipales. Con ello se busca incidir públicamente para lograr la preservación de estos ejemplares. Este cartel presentará la metodología de selección de árboles y el contexto que enmarca el proyecto.

**Cambios en la distribución geográfica de la “Liendrilla”, biznaga endémica y amenazada de México**

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*Astrophytum ornatum*, es una biznaga amenazada y endémica de México, cuyas poblaciones son poco abundantes y su distribución es limitada. La especie tiene valor ornamental y es utilizada como forraje. Con la finalidad de conocer los cambios que ha sufrido la especie en su distribución y evaluar el estado de sus poblaciones, se realizó una visita a
los sitios donde estaba registrada su presencia. La información se obtuvo de ejemplares herborizados (MEXU), así como de bibliografía especializada. Con el programa ArcGis 9.3, se elaboraron mapas de la distribución histórica de la especie. Para cada localidad se señaló la presencia o ausencia de la especie, su densidad poblacional, así como la extensión y tipo de la comunidad vegetal y el grado y tipo de disturbio que se presenta. De los 45 ejemplares herborizados, solo 60% cuenta con geo referencias. Se visitaron 33% de estos sitios, encontrándose que en 80% de ellos aún aparece A. ornatum. La especie presenta amplia distribución altitudinal, encontrándose predominantemente en matorrales xerófilos espinosos con sustrato calizo. Las comunidades bien conservadas cubren más de un Km², mientras que las alteradas son menos extensas y presentan densidades bajas de la especie (<1ind/50m²). Todos los sitios presentan algún grado de disturbio antropogénico. La falta de referencias geográficas, así como de información de las densidades originales impiden hacer comparaciones más precisas, por lo que se sugiere que en las colectas posteriores de especies en peligro se registren estimaciones de la extensión ocupada por las poblaciones, así como de sus densidades.

Dinámica de la población del cactus mexicano Turbinicarpus horripilus (Lem.) Vac. John & Riha en peligro
Jiménez Sierra, Cecilia Leonor; María Loraine Matías-Palafax, María C. Mandujano, Pedro Luis Valverde
Universidad Autónoma Metropolitana - Iztapalapa

Se presenta la dinámica poblacional de Turbinicarpus horripilus (Lem.) Vac. John & Riha, un pequeño cactus globoso nativo de México y en peligro de extinción. Sólo se conocen seis poblaciones, tres de ellas con menos de 100 individuos, la más grande con ≈1800. Se siguieron a 100 individuos de esta última población por dos años consecutivos. La fecundidad se estimó a través del censo mensual de frutos y del número de semillas por fruto. Usando un modelo matricial de proyección de Lefkovich se estima la tasa finita de incremento poblacional, lambda (λ), el valor reproductivo (v) y la estructura estable de edades (w). A través de una matriz de elasticidad se evaluó la importancia de los procesos vitales. Usando la cobertura de los individuos se observó una estructura de tamaños multivariada, que los adultos (A3 y A4) conforman el 64% de la población y que las plántulas fueron la clase más escasa (1.6%). Marzo fue el mes con mayor producción de flores, la producción de frutos se observó en ocho meses del año, el número de semillas por fruto fue bajo (37±2EE). La lambda promedio fue de 0.8892 (±0.06EE). El valor más alto de elasticidad se encontró en la permanencia (0.82). El crecimiento y la fecundidad presentaron valores pequeños (0,13 y 0,05). A pesar de la cantidad de semillas producidas (48319/año), el número de plántulas fue escaso. La mayor tasa de mortalidad se encontró en las clases de los adultos. No se sabe porque hay tan poco reclutamiento, probablemente los ciclos de reclutamiento se llevan acabo en periodos de tiempo más amplios como se ha observado en otros cactus del desierto.

Influence of surrounding vegetation on species composition of old fields in Central Europe
Jirová, Alena
University of South Bohemia

Old fields (47) were studied in the Bohemian Karst Protected Landscape Area in the Czech Republic. Complete list of species were surveyed in each field and in its surroundings up to the distance of 100m from the field margins. The colonization success of each species was expressed by an index between 0 and 1 which was obtained as the ratio of the number of relevés with species present in a field and the number of fields with the species occurrence in their surroundings. In addition, the colonization success was calculated separately for two types of late successional stages, namely shrubby grassland and woodland. Life-history traits of colonizing species were also considered (taken from databases). Land cover categories, occurring in the broader surroundings up to 1km, were surveyed using data from NATURA 2000 and elaborated in ArcView program. Vegetation data were analysed by ANOVA and ordination analyses. Generally, target (Querco-Fagetea, Festuco-Brometea and Trifolio-Geranietea), urbanofobic and C-strategy species were more successful in colonization and were typical for the latter stages of succession. The floristic statute (archaeophyte, indigenous, neophyte) life strategy (C, R) and urbanity (urbanophobic, urbanoneutral, urbanophilic) of species occurring in close surroundings are important traits enabling the species to participate in target communities. Regarding the broader surroundings, there is important participation of (semi-) natural vegetation for formation of target communities.

Culture and conservation in a plural society: Perspectives from local practitioners
Jones, Charissa; Tania Schusler, Monique Pool
Antioch University New England
Historically, conservation programs in developing countries have taken a top-down approach and mainly been conducted by international organizations. Such ‘fortress’ conservation has been critiqued and alternatives that include local knowledge and participation, such as community-based conservation, have increased in presence in the conservation field. As a part of the ecologically and culturally diverse Guiana Shield Region (GSR), Suriname, a small nation located in Northeastern South America, still contains approximately 80% of its biodiversity. Suriname is a plural society with no dominant language, political party, or religion and is home to ten distinct ethnic groups. For collaborative-based conservation programs to succeed in a plural society like Suriname, working within and across cultures is imperative. This research involves a grounded theory study to explore the intersection of culture and conservation and its implications for conservation in Suriname. In June and July 2011, I will conduct pilot interviews with local Surinamese conservation practitioners about their perceptions of conservation and nature; the criteria by which they deem conservation successful; the influence of their own ethnic background on their perceptions of conservation and nature; and their thoughts about the implications of culture for collaborative conservation in Suriname. I expect to find differences in practitioners’ perceptions of conservation that relate to their cultural beliefs and traditions. This poster will present areas of overlap and divergence in conservation practitioners’ perspectives, discuss implications for collaboration both within Suriname and with international organizations, and suggest lines of inquiry for further research on culture and conservation.

**Co-management and ecosystem restoration**

Kaplan, Ilene  
Union College/Woods Hole Oceanographic Institution

The development, implementation and enforcement of marine coastal habitat and community restoration projects will be more effective if stakeholders are involved in the policy process. Community “locals” and participants in many of the traditional commercial and non-commercial activities who contribute to both preservation and destruction are often overlooked or misunderstood; their status as “experts” may be considered suspect or marginal. This project examines the value of co-management in the policy process and examines oral testimony of members of New England fishing communities and the “loss” of both habitat and community. Scientific and educational opportunities are also presented.

**Automated vernal pool hydrological monitoring for efficient data collection**

Kedziora, Matt; John Kedziora  
AECOM

The California State Route (SR) 125 South vernal pool and Quino checkerspot butterfly (Quino) habitat restoration site is located in San Diego County, CA on Otay Mesa. The 52-acre site is mitigation for SR 125 South, a highway and toll road developed through a joint partnership project between South Bay Expressway, L.P. and the California Department of Transportation. Regulatory authorizations were issued for the project to impact vernal pools and the federally endangered Quino. AECOM provided oversight and preparation of the site restoration plans, as well as implementation of restoration activities and 5 years of maintenance and monitoring. Project activities included integrated restoration of Quino upland habitat and vernal pool watershed areas. Hydrological monitoring of vernal pools was completed to document vernal pool ponding and drying during the span of the project. The unique hydrological process is associated with the timing of numerous floral and faunal surveys. During the final year of the 5-year maintenance and monitoring period, a vernal pool hydrological monitoring device (KEDZIG) was installed. The device was constructed using a differential pressure sensor enclosed in a watertight, submersible unit constructed with PVC piping and custom plastic housing. The device captured automated hydrological data throughout the rainy season. The development and use of automated data collectors is an example of innovative natural resource management. The manual hydrological monitoring results are compared with the data from the device. A discussion of the benefits and limitations of the monitoring technology is provided.

**Técnicas de bioingeniería y paisaje natural para el control de flujo pluvial de las cuencas**

King, Jimmie  
Universidad de Monterrey

Monterrey, a city of four million located in Northeastern Mexico is one of the major industrial capitals of Latin America. In 2010, Hurricane Alex left a wake of destruction, resulting in loss of life and billions of dollars in damage including roads, highways and much of the basic infrastructure. Many communities of the Monterrey Metropolitan Area were isolated for days and even weeks, without access to food, potable water and health care except by
helicopter. Predictive models suggest that the intensity and frequency of major meteorological events will increase, placing a renewed importance upon the development of alternative mitigation methods. Founded upon this premise, mi río: CAMINO AL DIENTE was initiated as a pilot project by the University of Monterrey funded by the federal government. The principal objectives of project include the development of an integrated, watershed conservation and risk management plan for the Monterrey Metropolitan Area. The plan contemplates the restoration of stream morphology and impacted environmental systems, the establishment of land use controls, as well as the sustainable recreational use of flood plain districts through the creation of a system of linear parks. The program utilizes a participative planning methodology, incorporating citizens of the community in decision-making processes as well as participation in reforestation and river clean-up efforts, supported by formal and informal educational programs. Community participation is critical to the overall, long-term success and continuity of the project, as citizens become active stakeholders in the conservation of Mi Rio (my river).

Land use at the watershed scale: Restricted factors or opportunities for environmental rehabilitation? Case study in Buenos Aires, Argentina

Laffitte, Cristina Mariana; Gustavo Adolfo Zuleta, Diego Schell, Bárbara Guida Johnson
Universidad Nacional de Lomas de Zamora

Buenos Aires, one of the world’s 27 megacities, is located in one of the most contaminated watersheds: the Matanza-Riachuelo (200,000ha). Land uses are highly heterogeneous and unevenly distributed, and there is an increasing transformation of semi-natural remnants to urban use. Under this scenario, we assessed different land uses in order to determine which constrain ecological rehabilitation and which require restoration. We classified a Landsat image to obtain a land cover/land use map, and performed GIS analyses to generate an impervious surface map. Based on these data, an environmental quality map was developed. Currently, 57% of the watershed is under rural use and 39% is occupied by urban and mining activities, while only 4% remains natural but degraded. The original ecosystem has been transformed completely and 20% of the area is now impervious, which is the maximum value possible for proper functioning of any watershed. Besides, 10% of the area has impervious surface values higher than 60%, exceeding the threshold for environmental quality. Based on these results, areas where restoration would be feasible are quarries, brick kilns and green spaces (5,000ha). The peri-urban area (17,000ha) is an important interface since it provides opportunities for rehabilitation, mitigation and/or conservation. Other land uses such as urban, industrial, suburban and roads were restrictive. Pastures have an intermediate feasibility for rehabilitation or conservation. We discuss the contribution of these findings to propose land planning and environmental zoning of the watershed, as well as stakeholders’ involvement.

Native wildflowers and grasses for restoration projects described by Provisional Seed Zones in the Great Basin area of western USA

Lambert, Scott; Nancy Shaw, Andrew Bower
SML Native Plant Consultation

The Native plant materials development and increase project under the direction of the US Forest Service Rocky Mountain Research Station, US Bureau of Land Management and other conservation partners is conducting research on selected native wildflowers and grasses for future aridland site restoration seedings and plantings in the Great Basin area of the western USA. The Great Basin includes extensive portions of the States of Idaho, Oregon, Nevada, Utah, and California. A list of the native seeds within a Provisional Seed Zone is described. Provisional Seed Zones are designated areas with similar annual precipitation and maximum seasonal temperature range.

Ecologically restoration of a large urban waste landfill in Guangzhou, China

Lei, Nie
Guangzhou City College

With the advent of modern sanitary landfill closure techniques, the opportunity exists for transforming municipal landfills into urban woodlands. However, tree survival and wildlife habitat reconstruction in landfills are obviously threatened by harsh growing conditions and poor soil quality. Vegetation restoration and landfill soil amelioration were studied in Datianshan Landfill site in Guangzhou, which had been closed for 8 years. Environmental factors limiting the vegetation restoration on Datianshan Landfill site mainly included low fertility, high contents of heavy metals and the presence of relatively high concentration of landfill gas (LFG). To solve the above problems, soil amendments, e.g., green waste biochar fertilizer, ectomycorrhizae and CaCO
do were added to alleviate the phytotoxic effects of ethylene and methane on tree seedlings, obviate soil anoxic and acidic conditions, and to enhance metal
uptake. Thus, harmful effects of landfill gas and heavy metals on the growth of the vegetation in the landfill site were greatly reduced. Indigenous flowering tropical woody species with high ecological potentials and many environmental and aesthetic advantages, such as *Ficus microcarpa*, *Melastoma candidum* were selected for landfill plantings and tree-based bioremediation. The results showed that these native species could be well suited to cope with local landfill environments in a phytostabilization strategy. Several ecological criteria are recommended for the restoration of municipal landfills and similar degraded sites, in order to maximize rapid and economical establishment of native woodlands landscape.

Evaluación del banco de plántulas de *Ulex europaeus* (Retamo espinoso) en zonas con diferentes etapas del proceso de restauración, Embalse de Chisacá (Localidad de Usme, Bogotá - Colombia)

León Moya, Olga Adriana; Perla Natalia Ramírez
Universidad Nacional de Colombia

Se comparó el banco de plántulas de *Ulex europaeus* en zonas con diferentes etapas de un proceso de restauración, una primera zona con tres años de intervención fue objeto de quema y arado con tractor con el fin de eliminar la fitomasa del arbusto invasor, posteriormente se plantaron especies nativas de estratos herbáceo, arbustivo y arbóreo y se realizaron ocho extracciones manuales de las plántulas de retamo provenientes de los bancos de semillas acumulados; en la segunda zona, con dos años de manejo, la eliminación de *U. europaeus* se llevó a cabo mediante corte y arado, con quema puntual de los residuos y posterior plantación de especies nativas, se realizaron cinco extracciones de plántulas; las tres zonas restantes se encuentran en etapas iniciales en las que se eliminó la biomasa por medio de corte y arado, en dos de estas se presentó una quema de los residuos acumulados y se realizó una extracción de plántulas, tienen seis, cinco y cuatro meses de intervención respectivamente. Se presentaron diferencias estadísticas entre las zonas, principalmente con la primera en la que se observa una reducción en el banco de plántulas gracias al mayor tiempo de extracción y a la sinergia de los métodos de eliminación de la biomasa de la especie invasora implementados; también se encontraron diferencias entre los meses de muestreo para la mayor parte de las zonas evaluadas. En la zona con mayor tiempo de manejo se ubicaron los sitios con mayor presión de propágulos, ubicándose en áreas con mayor pendiente.

Monitoreo de la vegetación plantada y regeneración natural en áreas invadidas por *Ulex europaeus* (retamo espinoso) en los alrededores del embalse de Chisacá, Usme, Bogotá, Colombia

León Moya, Olga Adriana; Perla Natalia Ramírez
Universidad Nacional de Colombia

Este estudio presenta los resultados de la evaluación y seguimiento de un área piloto de restauración ecológica con tres años de manejo anteriormente invadida de *Ulex europaeus*, se evaluó durante dos períodos de lluvias y uno seco la respuesta del crecimiento y establecimiento de doce especies leñosas nativas sembradas, clasificadas en pioneras: *Smallanthus pyramidalis, Verbesina crassiramea, Solanum oblongifolium, Baccharis latifolia, Baccharis bogotensis* y *Lepechinia salviifolia*; y sucesionales intermedias *Vallea stipularis, Myrcianthes rophaloides, Hesperomeles goudotiana, Viburnum triphyllum, Xylosma spiculiferum, Alnus acuminata*. Adicionalmente, se caracterizó la composición actual de la regeneración natural, obteniendo un total de 62 especies, 67% corresponden a nativas, en cuanto a la estructura actual de la zona, el estrato herbáceo representa 52%, el arbustivo 21% y el arbóreo 20%, también se observan enredaderas nativas con un 7%. Los resultados obtenidos indican una fuerte influencia de las condiciones climáticas (debido especialmente a la ocurrencia de heladas durante el período seco), sobre las especies plantadas, principalmente las pioneras, las cuales logran recuperar la biomasa perdida en la posterior época de lluvias. Algunas especies como *H. goudotiana* y *L. salviifolia* se muestran resistentes al estrés, mientras *S. pyramidalis* y *V. crassiramea* son altamente afectadas. Estos resultados permiten determinar las especies que son eficientes en procesos de restauración en esta zona.

Prevención, control y manejo de especies exóticas invasoras en ecosistemas vulnerables de Camagüey, Cuba

León Sánchez, Coralía
Delegación del CIFTMA

El Proyecto GEF-PNUD “Prevención, control y manejo de especies exóticas invasoras en ecosistemas vulnerables de Cuba”, tiene un área de réplica en Camagüéy. Contiene tres salidas: Comunicación y capacitación al personal técnico-profesional y población en general; Legislación referida al trabajo u/o introducción de especies invasoras en
Cuba y Control y manejo de especies invasoras en ecosistemas vulnerables en Cuba. Las acciones de comunicación y capacitación consideran el desarrollo de talleres de capacitación en creación de viveros de plantas nativas; elaboración de folletos de tratamiento de invasoras y nativas arboreas para la reforestación de áreas saneadas; diseño de carteles de divulgación; ruedas de prensa y programas de radio y televisión. La legislación referida a las invasoras en Cuba aún muestra vacíos de conocimientos, que se resolverán con la concurrencia de personal jurídico y científico capacitado. Con respecto al control y manejo de especies invasoras incluye identificar y describir las invasoras en las áreas y las nativas que se pudieran ver afectadas; monitorear los recursos (suelo, agua, flora, fauna) a partir del cambio de vegetación de las áreas en cuestión; estudio fenológico de las especies invasoras; montaje y reforzamiento de los viveros de plantas nativas y naturalizadas en cada área; eliminación de especies invasoras con maquinaria pesada o manualmente y la siembra de especies nativas en terrenos liberados.

**Siembra de Polymita venusta (Stylommatophora, Helminthoglyptidae) en Reserva Florística Manejada Monte Natural Cupaynicú, Guisa, Granma**

León Sánchez, Coralía  
Delegación del CIFMA

La población de *Polymita venusta* en la Reserva Florística Manejada Monte Natural Cupaynicú, Guisa, Granma, se ha visto afectada por las intensas sequías que limitan la disponibilidad de alimento y hábitat, facilita la acción de depredadores importantes y reduce las condiciones favorables de temperatura y humedad relativas necesarias para la reproducción. En zonas aledañas a dicha reserva se reportó una población de este molusco terrestre afectada por la tala indiscriminada, incendios sucesivos y depredación animal y humana. Se realiza un estudio preliminar para siembra de *P. venusta* en Monte Natural Cupaynicú (marzo 2008-octubre 2009) que muestra la posibilidad de traslado efectivo de la especie. Después de 2 siembras de 100 y 500 individuos respectivamente se evidencia el elevado índice de adaptación al reportarse 5 muertes por depredación en el primer muestreo y de 0 a 2 muertes en los próximos 18 muestreos (enero-mayo 2010), logrando así la conservación de esta especie endémica de Cuba Oriental y en peligro de extinción.

**Growth of Myracrodruon urundeuva Allemão (Anacardiaceae) samplings implanted in the recovery of a riparian vegetation stretch of Pandeiros River in an area impacted by cattle in Brazil**

Lima Braga, Lilian; Yule Roberta Ferreira Nunes, Gracien da Silva Mota, Caroline Siqueira Santos, Lucas de Paula Dias Lima, Marcelo Henrique de Oliveira, Chirley Alves Coutinho, Wesley Alves Silva  
Universidade Estadual de Montes Claros

The high rates of fragmentation and disturbance on riparian forests underscore the need to restore these environments. Restoration projects usually use the planting of native species and therefore it is important to know the behavior of these species. This study evaluated the development *Myracrodruon urundeuva* Allemão samplings in different restoration models in a riparian vegetation area impacted by cattle through monitoring the growth of individuals established. The monitoring was conducted from January 2010 to February 2011 in four plots of 1 ha. Four treatments consisted of samplings planted in rows between two distances (2 and 4 m) and with the presence or absence of direct sowing (S), called T2, T2S, T4 and T4S. The total height and diameter at ground height (DGH) of 526 *M. urundeuva* individuals were taken. In order to detect possible differences between the growth and the used restoration models, analysis of variance (ANOVA) and Tukey post-test were made. The growth in diameter (gl=3, F=49.02, P<0.001) and height (df=3, F=28.15, P<0.001) varied among the models. The T4S (X=6.87±5.90mm) and T4 (X=5.61±4.13mm) models showed the highest values of DGH, which differs from T2 (X=0.81±4.74mm) and T2S (X=0.25±7.12mm). Similarly, the height growth was greater in the treatment T4S (X=41.48±37.87cm), followed by T4 (X=37.68±39.07cm), T2 (X=10.21±42.15cm) and T2S (X=7.77±34.84cm). Some authors cite the species studied as recommended for recovery and our results confirmed the good development of *M. urundeuva* samplings. Moreover, the best development of the species was observed in models with line spacing of 4 m, our recommendation for implantation in the field.

**Mangrove recovery brings wildlife back to desertified land at Guanabara Bay, Rio de Janeiro, Brazil**

Lira Medeiros, Catarina; Antônia Ozório Silva, Lívia Cardoso Teixeira Campos, Fabiano Salgueiro, Catarina Fonseca Lira-Medeiros  
Jardim Botânico do Rio de Janeiro
The Guanabara Bay basin has 4,600 km² and encompasses almost the entire city of Rio de Janeiro and part of 15 other cities. Originally, 262 km² of this basin were covered by mangroves, but currently only 82 km² is left. Of this, 65 km² are within a protected area. The degradation of the mangroves in this basin is mostly due to urban sprawl. In the city of Magé, there is an area of about 120ha where a mangrove forest is now completely degraded. The mangroves are known to have important ecological, economic and geophysical functions. Our work aims to recover, within this degraded area, the greatest extent of mangroves possible so that the ecosystem can recover all its functions. The work began with the creation of channels so the water from the bay could circulate within the desertified area, recovering part of the physical and chemical characteristics of natural mangrove forest soil. Subsequently Laguncularia racemosa trees were transplanted, and Rhizophora mangle and Avicennia schaueriana seedlings were planted in the area. We have already recovered 16ha using 44,000 seedlings from nurseries constructed in loco. Within this area, we originally observed one crab species, but currently there are six different species with millions of individuals. Also several bird species are visiting the area, including two flamingos observed once. The results so far have benefitted fishermen, crab collectors and the population living nearby. The area is often visited by schools and companies interested in the environment and in the mangrove recovery.

**Manejo de semillas y producción del guayacán Guaiacum sanctum con fines de restauración y de otras especies alternativas para producir madera para artesanía en torno, Dzityá, Yucatán, México**

**Loayza Cabezas, Sophia Cristina; José Secundino Chi Chi**

Asociacion de Artesanos de Madera Torneada de Dzitya A.C.

En la comisaría de Dzityá, Estado de Yucatán, la producción de artesanía en torno de madera de guayacán (Guaiacum sanctum). es una de las principales formas de subsistencia, actividad que ha perdurado y ha sido reconocida. Un factor limitante en la producción de artesanía, es la obtención de la materia prima de guayacán. Los ejidos y comunidades de los cuales obtienen la madera, cada vez son menos y más alejados; por lo que aumentan considerablemente los costos de producción. Cabe mencionar que el guayacán es una especie de muy lento crecimiento y tardada etapa reproductiva. Se encuentra en la lista de la norma ECOL-059, bajo protección especial. Aproximadamente el 95% de los talleres, trabajan este tipo de madera. Como una alternativa de desarrollo sustentable en la localidad, es el de fomentar la diversificación de materias primas, y promoción de especies nativas, de rápido crecimiento, de muy buena propagación y calidad de madera para realizar artesanía en torno, para lo cual se han identificado algunas especies como son el belsinanché (Alvaradoa amorphoides), chukum (Havardia albicans), chákte (Acasia platyloba), tzalam (Lysiloma latisiliquum). Como otro objetivo importante se promueve el manejo del guayacán Guaiacum sanctum, de forma participativa, relacionandolos con su biología, importancia en su conservación y futura restauración en áreas de la costa de Yucatán. Para lo cual se han realizados monitoreos para identificar la s etapas fenologicas de la especie en la zona, colecta, beneficio, pruebas de germinación y desarrollo en área sombra.

**The role of the cattle fields management in the maintenance of plant diversity and restoration potential: The case of two tropical regions in México**

**López Acosta, Juan Carlos, Betsabé Ruiz Guerra, Noé Velázquez Rosas**

Universidad Veracruzana

The tropical regions in Mexico are converted to a mosaic of anthropic uses where the cattle management is dominant. In this degraded areas, the efforts for the conservation and restoration ecology depend on identifying the ecological process and the capacity of the landscape to preserve it. In order to understand the importance of these elements in the plant diversity maintenance, we compared the number of individuals, diversity and community structure of woody plants (adults/saplings) within live fences and pastures in two sites with contrasting livestock management: Los Tuxtlas and Uxpanapa, importants tropical regions in Mexico. Plant species were classified by their dispersal syndrome and regeneration strategy (light demanding/shade tolerant). We recorded 2013 adult plants from 54 species and 756 saplings from 77 species within live fences, whereas pastures recorded 48 adults from 19 species and 194 saplings from 49 species, this show the high diversity content in the life fences. Considering regeneration strategies, the light demanding plants was 1.3 (species) and 4.8 (individuals) fold more common than the shade tolerant in both sites. In general, the richness, diversity, abundance of adults and saplings were highest in Los Tuxtlas than Uxpanapa. In both sites the zoochory (by birds) was the most important dispersal syndrome. Our results suggest that diversity in live fences promoted by the management in “Los Tuxtlas” support a high diversity of woody plants from mature forest (tolerant). Diversification and promote this strategy is useful for maintain/enriches the plant diversity in livestock tropical regions.
Characteristics of phosphorus fractions in sediments from natural and constructed wetlands in
north of China
Lu, Jin; Hai-ou Zhao, Juan Peng, Huai-dong Zhou, Bo Gao, Hong Hao, Xiao-ru Liu, Ji-jun Gao, Gao-feng Zhao
China Institute of Water Resources and Hydropower Research

In this study, the characteristics of phosphorus fractions in sediments from natural and constructed wetlands in the north of China were investigated using a soil P fractionation scheme. For seven sediments, TP varied from 531.9 to 1177.3 mg kg-1 and Pi was the main P fraction which accounted for 88.5 to 95.6% of TP. Along the flow direction, TP and Pi in sediments decreased gradually from Yongding river (upstream inflow) through the stabilization pond sediment (inlet) to the constructed wetland treatment system (Heituw wetland, covered with various wetland vegetation types), but increased significantly (maximum value) at the outlet of the wetland (no wetland vegetation). Po fractions increased along the flow direction (ranged from 23.4 to 123.0 mg kg-1) and significantly correlated with organic matter. The characteristics of phosphorus fractions were significantly different in wetland sediments without or with reeds and cattails. This study indicates that the Po in sediment may become a potential source of available P for constructed wetlands, although it was considered as the highly resistant fraction, and its accumulation and release may primarily depended on OM composition and wetland vegetation.

Transforming the urban face: Contributions of restoration ecology to the well-being of urban
impoverished communities
Luna Díaz, Adriana; Eric Higgs, Brian Starzomski
University of Victoria

In the XIX century, approximately 3% of the population lived in cities; today, thanks to the industrialization and globalization, more than the half of the world population live in cityscapes. This trend, joined to an increasing demand for resources and to the unequal distribution of environmental burdens of development, implies an important and increasing stress on social and ecological systems. The impoverished communities inhabiting in Severely Degraded Urban Areas are, arguably the best example of the combination of the crises derived from those stresses. In Mexico City - a city with a population density of approximately 6,000 hab/km² and where 59.8% of the households are considered to have a low and very low social development, an enthusiastic yet reduced number of organizations share the vision and conduct different efforts of ecological restoration (ER). The final aim of this project is to promote support for these kind of initiatives by asking: What are the potential contributions of ER in urban impoverished areas to improve the quality of life of the inhabitants of the most neglected areas of the cities? By investigating, developing and assessing a simple framework that can be used to evaluate the social impact of ER in the well-being of impoverished urban dwellers in Mexico City, we aim to attract attention to the efforts in marginalized areas at the same time that we provide restoration practitioners with a tool whether for planning strategies and/or for attracting human or material resources to their enterprises.

Conceptual framework for roadcut restoration
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Roadslopes are new degraded ecosystems where physical and chemical conditions have been severely modified from the original ones. On these environments, ecosystem management is needed to recover functionality and to foster plant colonization. Roadslope restoration is usually carried out by applying standard techniques which are not effective. Recent studies highlight the importance of understanding the dynamics of degraded ecosystems, and the links between structure and function to align restoration actions with the goals of increasing local natural capital and providing those ecosystem services locally required. In this sense, the development of conceptual framework about how degradation affects biological processes provide some clues about which thresholds must be overcome to achieve restoration goals. Thus, we present a conceptual model in which we analyze processes driving roadcuts degradation and how they affect community assembly through reducing germination and vegetation establishment. In roadslopes, steep slopes, regular surfaces and soil compaction enhance runoff. This not only limits seed and sediment retention but also increases nutrient loss and reduces plant recruitment. Positive feedbacks among such processes maintain roadcuts in a degraded state. In our model, we suggest that roadcut conditions management by topsoiling and microtopography manipulations could trigger a switch from positive feedbacks to negative ones, which may lead to ecosystem structure and function recovery. We surmise that decision making based on a conceptual framework reduces costs and increases restoration effectiveness.
Coverage of the soil by the crown of the trees in forest restoration plantation under different spacing

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This study aimed to evaluate the coverage of soil by the crown of the trees in forest restoration plantation under different spacings. The study was conducted in the Thermoelectric Plant Barbosa Lima Sobrinho in Seropédica, Rio de Janeiro. The planting was done between October and December 2004 under the spacings 1.0 x 1.0, 1.5 x 1.5, 2.0 x 2.0 and 3.0 x 2.0 meters. Four plots of six lines and five planting holes were installed per spacing, thus the plot area varied, but the same number of plants was measured in each spacing. Five years after planting the width of the trees crowns was measured in two directions, longitudinal (L) and transversal (l) to the planting row, with this, the crown area was calculated, with the ellipse formula (CA = ((L * l) * π) / 4), the sum of the crown areas of each plot was extrapolated to hectare resulting in canopy cover index (CCI), which represents the proportion of soil covered by the crown of the trees. The average values of CCI observed were, respectively, 5.2, 3.5, 2.4 and 1.6. The value verified for the 1 x 1 m spacing, was not statistically different from the 1.5 x 1.5 m, and was significantly higher than those observed in the other two spacings (Tukey, p <0.05). CCI values were higher in dense spacings indicating, five years after planting, greater canopy coverage of the soil under these conditions.

Urban workforce productivity in soil preparation for forest restoration in Pedra Branca State Park, Rio de Janeiro, Brazil

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This study aims to evaluate the labor productivity of urban workers, with no experience in rural work, to prepare the soil for forest restoration plantation in the Pedra Branca State Park (PEPB), Rio de Janeiro City, Brazil. The PEPB is a protected area located in the west zone of Rio de Janeiro. The project is restoring 204 hectares of Atlantic Forest located in slope area with mean declivity of 15° in the north side of the park. The employed workforce is from the urban local communities and does not have any skills or previous experience with rural activities. In this study we considered as soil preparation the implementation of strip weeding through the contour line. The strips width is about 1.50 meters and its length is variable. The prepared area is measured weekly with a measuring tape, weekly values relating to the same month are summed to obtain the monthly production, which is divided by days worked and number of employees, resulting in productivity. Preliminary results from December 2010 to March 2011 were respectively 24, 37, 56 and 86 m²/men/day of production in soil preparation. Although it is improving, the productivity remains below 144 m²/men/day taken as reference for reforestation in the city of Rio de Janeiro. Based on the improvement of productivity it is estimated that workers take 6-8 months to adapt to this activity.

Sucesión de especies vegetales para la rehabilitación de un suelo salino

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Se realizaron dos muestreos de suelos y plantas, uno en temporada húmeda y el otro en seca, en los suelos salinos localizados entre Maguey Blanco y Taxhado, Hidalgo, México, con el fin de relacionar las características químicas del suelo con la composición vegetal que se ha establecido en él. Se trata de una zona donde la cobertura vegetal desarrollada es tolerante a la salinidad y los cambios en la composición de especies fueron utilizados como indicador de variaciones en la concentración y composición de sales en el suelo. Se determinaron 12 especies dominantes en el sitio. Con base en el análisis del suelo de la zona radical, se definió para cada una de ellas su intervalo de tolerancia a la salinidad, se encontró que en época húmeda las especies más representativas fueron: Cynodon dactilon, Atriplex suberecta y Heliotropum curassavicum, es decir, las más sensibles, mientras que en temporada seca fueron: Hordeum jabatum y Spergularia marina como las más tolerantes. Con base en su tolerancia se ha elaborado una secuencia de las mismas para ser utilizadas en la rehabilitación de suelos afectados por este problema, atendiendo a la composición cuantitativa de sales.
**Functional diversity along the successional trajectory: A potential tool for evaluating the restoration success**

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During succession, ecosystem structure such as species diversity and community organization and structural complexity are restored. The evaluation of a restored ecosystem is generally descriptive and considers only few parameters (for example, species richness and abundance) and rarely uses metrics that represent ecologically important multiparameters. Here we described tropical forest succession based on convergence and divergence of attributes (TCAP – trait convergence assembly patterns and TDAP – trait divergence assembly patterns, respectively) in the successional process of tropical forests. We compiled data from 25 restored forests ranging from 4-120 years and attributes (life form, stratum, leaf partition, leaf index, dispersal syndrome and pollination syndrome) of 297 woody species. Data were analyzed using algorithms based on multiplication and partial correlations between different arrays, which permit the discrimination of the relevance of TCAP, TDAP in the successional gradient, and the generation of indexes of functional diversity. The results indicated that functional diversity (TCAP and TDAP) increases during the succession process that probably derive from environmental filtering and species interactions during succession. We propose that the analysis of changes in functional diversity is a possible tool for evaluating restoration.

**Restauración de bosques templados: Estudio de caso "El Porvenir"**

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Los procesos de degradación ambiental son una amenaza para las áreas rurales que las coloca en una posición poco favorable para su desarrollo. La deforestación y degradación del suelo tienen como consecuencias el cambio de los ecosistemas, el paisaje y la reducción o desaparición de otros servicios ambientales. Lo anterior genera un empobrecimiento real de las zonas rurales y en ocasiones la migración de los habitantes hacia otros centros de población. El Programa de Reforestación de la Comisión Nacional Forestal (CONAFOR) del gobierno mexicano apoya, coordina y evalúa las acciones de forestación y reforestación a nivel nacional; además fomenta y promueve la producción de plantas de calidad para su utilización en la restauración de los ecosistemas forestales. El objetivo del programa es reforestar, con amplia y efectiva participación de la sociedad, mediante la utilización de técnicas y especies apropiadas a las condiciones ambientales de cada región. Este trabajo presenta el caso de la recuperación de la microcuenca del Mezquital en Hidalgo, México para mostrar los beneficios que las intervenciones derivadas de los programas gubernamentales pueden tener en zonas ambientalmente degradadas.

**Restauración de una cantera sujeta al aprovechamiento de caliza y arcilla en un ecosistema semiárido del noreste de México**

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La presente investigación se desarrolló en un ecosistema semiárido impactado por actividades extractivas propiedad de la Cementera Holcim-Apasco en el municipio de Ramos Arizpe, Coahuila, Mexico, en la cual surge la necesidad de la restauración. Dentro del predio se establecieron tres áreas de evaluación, dos tratamientos establecidos en una escala de tiempo de cuatro (SR4) y ocho (SR8) años y un área sin afectación, a manera de testigo (ST). Se estima la riqueza y diversidad de las especies vegetales (≥ 1cm) e indicadores ecológicos. Mediante la prueba de comparación de medias se encontraron diferencias significativas en la dominancia, densidad y alturas. En cuanto a la diversidad y riqueza no mostraron diferencias, derivado del registro de 14 especies en común, lo cual influye en la riqueza por efecto de las especies más abundantes. Por lo que en una escala de tiempo se observa una línea de recuperación positiva (SR4 y SR8 en relación con la línea base o tratamiento testigo ST). Por lo que la incorporación de especies nativas y adecuación del relieve favorece el establecimiento de la composición y estructura de las comunidades vegetales del ecosistema original. Palabras clave: semiárido, restauración, diversidad α y β.
Stem anatomy and flexibility of four wood species to water courses biotechnical management

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The use of vegetation is a common tool in Soil Bioengineering; the plants, in this case, must have flexible stems, among other characteristics. The present work aims to investigate the wood anatomy and the stem flexibility of four species: Phyllanthus sellowianus Müll. Arg. (Phyllanthaceae), Sebastiania schottiana (Müll. Arg.) Müll. Arg., Salix humboldtiana Willd. (Salicaceae) and Salix x rubens Schrank (Salicaceae). The material was collected in Rio Grande do Sul – Brazil. For wood anatomical descriptions followed the IAWA Committee. The flexibility studies used fifty stem samples, with different diameters, for each species. The results showed that the modulus of elasticity is not a good parameter to evaluate stem flexibility; in substitution, a new parameter was created: the “angle of flexibility”. Phyllanthus sellowianus showed to be the most indicated species to bioengineering works, followed by Sebastiania schottiana, Salix humboldtiana and Salix x rubens. The prune or even the cut of adult trunks of these species give much protection to slope stability due to the production of younger and more flexible stems. The wood anatomy of Sebastiania schottiana and Phyllanthus sellowianus, here described by the first time, also supports the recent separation of the last species from the Euphorbiaceae. The great similarity within all studied species configures a “reophyllous anatomical syndrome”: abundant gelatinous fibres, small vessels, thin rays and absent or rare axial parenchyma; from these features, the presence of gelatinous fibres may be considered as the most important to stem flexibility.

Enrichment of restored area through epiphytes transplantation, in semideciduous seasonal forest

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Enrichment using non-arboreal life forms, such as epiphytes, is critical to the development of restored forests in fragmented landscapes, where natural dispersal is scarce. Epiphytes are plants that grow on top of other plants (phorophytes). They play very important ecological role, performing nutrient cycling and providing microenvironments and food to other life forms. Features of phorophytes, climate, and microclimate influence local diversity of epiphytes. In order to improve success of enrichment in restored areas, it is important to determine if species present regeneration niches. This work aims to assess if six epiphyte species among Bromeliaceae, Orchidaceae and Cactaceae from Seasonal Semideciduous Forest are able to survive and grow when transplanted to different regeneration niches in a restored forest, planted in 1986. In 2011, 180 individuals of epiphytes were transplanted to 30 individuals of six different host tree species, two species for each of the following groups: evergreen, semideciduous, and deciduous. Host trees within each group were distinct for bark roughness. Data are currently being collected, which will be done for a total period of one year. Statistical analyses of survival and growth measurements in epiphytes will allow us to: (1) rank epiphyte species according to their survival and growth within each phorophyte group; (2) determine if epiphytes show preference for any phorophyte groups; (3) suggest
better epiphyte transplantation practices to forests undergoing restoration, therefore, boosting the success rate of non-arboreal life forms introduction in restored forests.

Reconocimiento exploratorio de la fenología de especies en una comunidad de Campo Sujo con minería de níquel, Barro Alto, Goiás, Brasil

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El bioma Cerrado presenta elevada riqueza florística, concentrándose el mayor número de especies en el estrato herbáceo-arbustivo. Sin embargo, poco se conoce de la fenología en la faja herbáceo-subarbustiva en áreas de Campo Sujo. El reconocimiento de patrones fenológicos de flora local permite trazar estrategias de manejo y conservación, importantes para el éxito de proyectos de recuperación de áreas degradadas por la minería de níquel. El objetivo de este estudio fue el reconocimiento exploratorio de la fenología de las especies de una comunidad de Campo Sujo en Barro Alto, Goiás, Brasil. El estudio fue desarrollado en una localidad con extracción de níquel. Clima Aw, con dos estaciones bien definidas, una caliente y lluviosa y otra fría y seca. Las mediciones fueron realizadas mensualmente durante un año. La floración en la comunidad está distribuida durante todo el año, pero con mayor concentración de especies floreciendo en la estación seca, contrario a lo reportado en estudios similares, en los que la floración fue registrada en la estación lluviosa. Fue posible distinguir patrones de reproducción bien definidos para nueve especies. Un primer grupo concentra sus estrategias de reproducción durante la estación seca: Ayapana amygdalina, Chromolaena chasseae, Hypenia brachystachys e Justicia lanstyakii. El patrón de Stachytarpheta gesseriooides fue observado durante la estación lluviosa. Un tercer grupo de especies florecen durante todo el año: Chamaesyce viscoideas, Heliotropium salicoides, Loudetiopsis chrysothrix y Oxalis pyrenea.

Indicadores florísticos y fitosociológicos para evaluar la recuperación de áreas degradadas en Cerrado sensu stricto en la Hacienda Agua Limpa, Brasilia, Brasil

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Se cree erróneamente que un área reforestada es un área recuperada. Para promover la recuperación de áreas degradadas como conservación efectiva y manejo eficaz del ecosistema es necesario evaluar las actividades de recuperación con la adopción de indicadores ecológicos de sustentabilidad. En Brasil existen trabajos de ese tipo, pero escasos y recientes. El Cerrado es el segundo bioma brasileño, considerado un hotspot por poseer elevada biodiversidad, alto grado de endemismo y estar seriamente amenazado. El objetivo de esta investigación fue evaluar un proyecto de recuperación en áreas degradadas del Cerrado sensu stricto, después de 20 años de perturbación en la Hacienda Agua Limpa, por medio del análisis de la composición florística y de la estructura fitosociológica de la vegetación leñosa. El experimento se llevó a cabo en el Cerrado sensu stricto, ubicado en la Hacienda Agua Limpa, estación experimental de la Universidad de Brasilia, Brasil (15°56' - 15°59' S; 47°55' - 47°58' W). El clima es Aw y el suelo Rojo Latosólico. Fue realizado un inventario forestal en 18 parcelas de 1000 m². Fueron colectados 5125 especímenes pertenecientes a 78 especies, 57 géneros y 36 familias entre las cuales Fabaceae, Vochysiaceae, Malpighiaceae, Apocynaceae y Melastomataceae fueron las más representativas, Miconia pohliana, Piptocarpha rotundifolia y Roupala montana fueron las especies con mayor Índice de Valor de Importancia, estimando su densidad en 2847.22 ind.ha⁻¹ y área basal en 11.62 m².ha⁻¹.

Detecting potential facilitator species in a disturbed lava field at south of Mexico City

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To improve restoration strategies, it is necessary to study the factors and processes that influence the structure and dynamics of the plant communities. Traditionally, negative interactions have been studied as the main biotic factors structuring plants communities. Recently studies have been incorporating the positive interactions, in particular facilitation as a biotic structuring force in several ecosystems. In harsh or limiting environments several plant species ameliorate physical conditions, which is an advantage that might be useful for ecological restoration. The study area is a disturbed lava field with scarce soil and a long dry season, located at the south edge of Mexico City. We evaluated the natural recovery under potential facilitator species and compared species richness and plant abundance beneath these and outside of their crown, in open sites. Human disturbance reduced plant diversity and vegetation biomass. Six species with the highest structural dominance were common to all disturbance sites. Two trees (Buddleia cordata and Dodonaea viscosa) and two shrubs (Eupatorium glabratum and Sedum oxyypetallum) were...
identified as potential facilitators. Plant abundance and species richness were significantly higher under the canopies of these species, than in open sites, except under *Donacaea viscosa* crown. Because facilitator species ameliorate extreme conditions and alter flows of energy and resource, they favor a patchy vegetation distribution, affect species diversity and modify the presence or absence of other species. In anthropogenic disturbance, facilitation might be the key to restore the plant community, mainly in harsh environments.

**Biological soil crust affects seedling rooting in a *Stipa tenacissima* steppe**

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In drylands, plant cover is sparse, and soil is commonly covered by biological soil crust (BSC). BSC is composed of cyanobacteria, lichens, mosses, algae and fungi. Various studies have shown that seedling establishment can be affected by BSC presence. But studies on drivers of such interactions are scarce. We evaluated BSC effect on germination and rooting of two key species in Stipa tenacissima steppes, the resprouting shrub *Pistacia lentiscus* and the perennial grass *Brachypodium retusum*. Our hypotheses are (1) BSC effect on plant performance depends on their effect on surface soil microtopography and hidrophobicity, and (2) importance of these drivers will be different in germination and rooting phases. We evaluated germination of *Pistacia* and *Brachypodium* seeds sown on Petri dishes containing unaltered BSC sampled underneath *Stipa* tussocks (TC), and soil from open areas covered (OC) and devoid (OU) of BSC. After eleven weeks, we quantified the number of rooted seedlings. Then, we characterized the type of surface and measured soil concavity and hidrophobicity underneath each seed. Germination was not affected by BSC type. In contrast, the proportion of rooted seedlings was higher in TC than in OC. Abiotic factors and the cover of BSC components were not correlated with *Brachypodium* germination or rooting. In *Pistacia*, microtopography and lichen cover were correlated with seed germination and seedling rooting, respectively. Our results highlight the complexity of BSC-vascular plants interactions and have strong implications on the use of BSC in dryland restoration.

**Análisis de los factores que repercuten en la densidad de aves nidificantes en un humedal construido para la depuración de aguas residuales urbanas**

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En los humedales construidos para la depuración de aguas residuales a menudo se persiguen otros objetivos adicionales. En las zonas costeras mediterráneas de la península ibérica, por dónde discurren muchas de las rutas migratorias de las aves, éste objetivo adicional suele ser favorecer la biodiversidad de la avifauna, bien como lugares de descanso o hibernada o como zonas de nidificación. En este estudio se pretendía averiguar que factores favorecían la mayor densidad y riqueza de parejas nidificantes, en un humedal construido para la depuración del agua en la desembocadura del delta del Llobregat (España). Para ello se hizo un censo de los nidos de aves, se estudió la estructura y la cobertura de la vegetación y se analizaron las características físicas y químicas del agua de cada una de las celdas del humedal. Se ha observado una relación inversa entre la cobertura de vegetación y el porcentaje de saturación de oxígeno así como entre la cobertura de vegetación y la densidad de nidos de *Fulica atra*. En las celdas del humedal con menor cobertura vegetal también se ha detectado menor concentración de fósforo reactivo soluble. Estos resultados sugieren que una mayor heterogeneidad del hábitat, con zonas cubiertas por vegetación emergida y zonas descubiertas donde proliferen la vegetación sumergida, favorece tanto la eficiencia en la depuración de fósforo como en la densidad de nidos de aves herbívoras.

**Restauración de pastizales templados en un área protegida de la pampa agrícola argentina para la recuperación de su valor de conservación**

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En la región pampeana de Argentina la restauración de pastizales para conservación de la biodiversidad nativa requiere un manejo activo para controlar especies exóticas dominantes. Se presentan los resultados de cinco años de seguimiento, en los cuales se evidencia la reducción en la abundancia de una hierba exótica invasora (*Dipsacus fullonum*) y el aumento de las gramíneas que actualmente dominan el paisaje, delos géneros *Stipa*, *Bromus*, *Nasella*, en un relict de pastizal templado en la pampa agrícola argentina intervenido con cortes frecuentes y aplicación de herbicidas. A partir de la comparación de la lista actual de especies con datos de los primeros inventarios realizados en la zona (1930) se elaboran algunas conclusiones sobre el valor de estos relictos y sobre su manejo.
Modelling wetland connectivity for the protection of migratory shorebirds in Greece

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In the annual cycle of long-distance migrant birds, en route periods provide numerous challenges, risks and selective pressures. Intact migratory routes with adequate stopover opportunities are critical for survival. Conserving migratory pathways for shorebirds poses a unique set of challenges, because many reserves scattered across space are required for the conservation of any one species. The Balkans are very important for Palaearctic migratory wetland birds. Especially Greece, with its extension deep into the Mediterranean, forms a bridgehead from and towards Africa. Our research intends to study the connectivity of Greek stopover sites for migratory wetland birds. Because the spatial distribution, temporal availability and quality of potential stopovers affect which pathways birds use during migration, we apply the Flight Leg Allocation Problem model (FLAP), to identify optimal configuration of stopovers for bird conservation. Using FLAP we intend to illustrate how certain migratory wetland birds might respond to changes in the temporal and spatial distribution of available wetland stopovers. We tried to identify important links in the chain of successive wetland sites. Since routes and sites during migration are relatively restricted, it might appear that some geographic locations are more critical than others. In this way we can suggest priority sites for conservation and restoration in Greece and the wider Balkans for the protection of migratory birds. This is important in view of the political and governance complexity migratory birds cross while flying this EU and non-EU stretch along their route.

Leña y carbón vegetal: Una alternativa dendroenergética para la inclusión de procesos de recuperación de ecosistemas boscosos.

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Basados en el supuesto de que una de las mayores presiones sobre los bosques andinos de Colombia es la extracción de madera para la producción de energía, se propone la inclusión de un enfoque socioeconómico en los modelos de restauración o recuperación de aquellos ecosistemas boscosos que se ven deteriorados por las comunidades que buscan la consecución de este recurso. En este enfoque se integran dos aspectos principales, el primero hace referencia a la concertación con las comunidades mediante análisis cualitativos y cuantitativos que permitan la selección de cierto número de especies que enriquezcan el modelo de recuperación para la obtención de productos dendroenergéticos, permitiendo así que la población no recurra a la utilización de gran número de especies si no solo de aquellas que han sido seleccionadas para tal fin; el segundo aspecto es la vinculación de asesores técnicos que capaciten a las comunidades en metodologías para el secado natural de la madera así como la producción de carbón vegetal a fin de lograr mayor eficiencia en el proceso de producción de energía reduciendo así de forma notable la presión sobre el bosque que se recuperara.

Constraints on wet pinelands restoration

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Fire suppression leads to encroachment of woody vegetation into herbaceous ecosystems worldwide. Without fire, wet pinelands of the southeastern United States have transformed from open grass dominated communities to shrub thickets. To examine the potential for restoration of wet pinelands converted to shrub thickets by fire suppression we quantified the seed banks, using the seedling emergence technique, and the responses of total vegetation cover to the following multi-plot, multi-site treatments: 1) Thicket - shrub thickets with no modification; 2) Cleared - above-ground woody vegetation removal via GyroTrac + prescribed fire + herbicide applied to woody resprouts; and 3) Disked - same as Cleared, but followed by soil diking. The Disked treatment significantly reduced woody ground-and canopy-cover, showed little resprouting and increased herbaceous cover, while the Cleared treatment did not reduce the resprouting of woody species. Ten months after treatment, four species (Rhedia alifanus, Drosera intermedia, Xyris brevifolia, and Hypericum sp.) common to fire maintained wet pinelands were found in vegetation surveys and seed banks of the Disked treatments. These four species were found in seed banks of the Thicket and Cleared treatments, but not found in the associated vegetation surveys. Thus, soil diking may have helped express the seed bank and reduce woody cover. However, in systems that have been fire suppressed for decades, the vegetation and seed bank analyses indicated that the seed bank will be insufficient to restore the understory community composition without additional management activities such as direct seeding or planting.
Production and development of mangrove seedlings in nurseries at Rio dos Cachorros, Amazonian Coast of Maranhão State, Brazil

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The Amazonian coast, comprised by the Brazilian states of Maranhão and Pará, contains the largest continuous mangrove system in the world, measuring 8,900 km². Maranhão has an extensive coastal line with 640 km² and is under a macro-tidal regime, with tides ranging up to 8 m. Mangroves are well developed with a biomass near 300 ton ha-1 and tree heights up to 40 m. In order to restore a mangrove area of 1.5 hectares for stabilizing a slope affected by dredging activities in the Rio dos Cachorros estuary, seedling production of mangrove species Rhizophora mangle, Avicennia germinans and Laguncularia racemosa was carried out from March 2009 to December 2010. A nursery of 15m x 20 m area was built near the restoring site with a full capacity for 28,000 seedlings. It produced an extensive baseline to provide ecological information, with oceanographic, climatic, geochemical and biological parameters. Salinity, pH and herbivory of seedlings were monitored. Almost 150,000 seedlings of mangrove trees of all three species were produced. The herbivores were found mostly in the rainy season and were comprised of insects such as Odonata (Argia sp), Orthoptera (Acrididae) and larvae of Lepidoptera, Diptera. Crabs, Aratus pisonii, were found stealing small seedlings in the nursery. Salinity management and feeding crabs with fallen leaves of nearby mangroves kept mortality at the nursery at very low rates, usually less than 3% of all produced seedlings.

Mangrove restoration in Sao Luis Island, Amazonian Coast of Maranhão State, Brazil: Structural development and mortality in planting sites

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In order to restore a mangrove area damaged by dredging activities nursery grown seedlings were planted from April 2009 to December 2010. Plant height and the diameter at the base (DAB) were measured, leaf herbivory, phenology and mortality data were calculated and monitored. In October 2009 the mean plant height for the red mangrove Rhizophora mangle was about 35 cm with a mean DAB of about 15 cm. In December 2010, R. mangle presented a mean height of 75 cm and a mean DAB of 30 cm. For the black mangrove, Avicennia germinans, in October 2009 the mean plant height was about 30 cm with a mean DAB of 5 cm. In December 2010, A. germinans showed mean plant height of 115 cm and mean DAB of 35 cm. For the white mangrove, Laguncularia racemosa, in October 2009 the mean plant height was about 5 cm and the mean DAB of about 5 cm. In December 2010, L. racemosa presented a mean height of 135 cm and a mean DAB of 25 cm. In relation to phenology A. germinans first flowers appeared in September 2010, while L. racemosa flowered in November 2010 and R. mangle in February 2011. Results showed that A. germinans presented the lowest losses of planting seedlings, with 5.56% of mortality, followed by L. racemosa with 8.47% of mortality while R. mangle showed the highest mortality values with 12.5% of planted seedlings.

Forest restoration and carbon sequestration monitoring using geospatial techniques

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Since 2001, over 2700 ha of restoration areas have been implemented on the surroundings of the AES hydroelectric power plants reservoirs in the State of São Paulo – Brazil. Over the last 2 years, a carbon stock inventory has been applied by means of fifty five 400 m² permanent sample plots of full botanical and biomass identification inventory. Information on biomass and carbon has been gathered for the entire forest system, including underground and aerial parts of the heterogeneous native forest by the use of mathematical models already developed in other studies related to native reforestation in the same regions. Given the difficulties normal means of inventory, this research explores the use of geospatial technologies such as GIS, remote sensing and applied GPS techniques, to monitor both quality of restoration and quantity of carbon sequestration. The use of new satellite imagery such as the Red Edge band present on the RapidEye sensors and NDVI (Normalized Difference Vegetation Index) have been used to stratify different plantation ages by quality and biomass quantity. Outputs from this research ensure quality monitoring of a large plantation area, therefore guaranteeing maximum ecological restoration. Furthermore, correlations between the vegetation indices and the permanent plot samples inventory result in overall estimates of biomass and carbon stock for further carbon credit trades. Future studies include the addition of over 50 more sample plots to the system and creation of better computer based models with more variables such as soil composition and climate.
Interference of *Brachiaria decumbens* and *Ipomoea grandifolia* on four neotropical trees

**Monquero, Patricia Andrea; Alessandra dos Santos Penha, Izabela Orzari, Andreia Cristina da Silva Hirata**

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Seasonal semideciduous forests from southeastern Brazil have experienced intensive fragmentation. In this sense, the interference of high densities of weeds can affect the dynamics of restored communities due to different ecological plant life histories. We determined if there were specific weed densities of *B. decumbens* (signal grass) and *L. grandifolia* (morning glory), beyond which the growth of seedlings of four neotropical tree species - *Acacia polyphylla*, *Enterolobium contortisiliquum*, *Ceiba speciosa*, and *Luehea divaricata* - would be negatively affected. We did a randomized experimental design with five treatments (different weed densities per pot per tree species). After the flowering of weeds, we measured height and stem diameter of seedlings, weighed their aboveground dry biomass, quantified the relative contents of macro and micronutrients, and their leaf percentages. We found that seedlings of four native tree species had their growth negatively affected by the lowest weed density (two weeds/pot), both in coexistence with signal grass and with morning glory, thus confirming our assumption. Relative contents of macro and micronutrients decreased with the coexistence of four native species with both weed species. In general, we observed significant decreasing of leaf percentages of macro and micronutrients, especially with eight weed plants/pot. We discussed that plant competitive performances could be related to the fast growth of root system of stress-tolerant plants. This could warrant experimental practices in chemical control of morning glory and signal grass in restored areas. Thus, we argued in favor of using alternative practices of management beyond the mechanical control of weeds.

Herbicide selectivity on tree species *Acacia polyphylla* and *Enterolobium contortisiliquum* (*Fabaceae*), *Ceiba speciosa* and *Luehea divaricata* (*Malvaceae*)

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We aimed to evaluate the selectivity of imazapyr, glyphosate, metribuzin, and sulfentrazone herbicides when applied on four native species of semideciduous forests from Southeastern Brazil: *Acacia polyphylla*, and *Enterolobium contortisiliquum* (*Fabaceae*), and *Ceiba speciosa* and *Luehea divaricata* (*Malvaceae*). We chose such treatments, the application of imazapyr (125, 250, 500, 1000, 2000 e 3000 g ha-1), sulfentrazone (100, 200, 400, 800, 1400 e 2400 g ha-1), glyphosate (90, 180, 360, 720, 1440 e 2160 g ha-1) and metribuzin (360, 720, 1920, 2880, 5760 e 8400 g ha-1), besides the control, without any herbicide. We evaluated phytotoxicity symptoms 30 days after application (DAA), and also dry biomass of leaves. We carried out a completely randomized design, with four replicates per treatment. Experimental plot comprised one seedling with 30 cm height. We concluded that glyphosate presented the lowest selectivity in relation to four tree species; therefore, we suggest that its application could be done through direct applications. Behavior of four tree species varied in relation to selectivity of herbicides. For *C. speciosa*, imazapyr was the most selective, followed by sulfentrazone. Metribuzin was selective for *A. polyphylla*. In relation to *E. contortisiliquum*, metribuzin presented the lowest phytotoxicity, followed by sulfentrazone. For *L. divaricata*, only sulfentrazone presented selectiveness.

**Establecimiento de plantas de *Bouteloua gracilis* inoculadas con hongos micorrizógenos arbusculares y sometidas a sequía en condiciones de invernadero**

**Monroy Ata, Arcadio; Ramón Osvaldo Rodríguez-Calderón, María Socorro Orozco Almanza, Esther Matiana García Amador**

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Con el objetivo de determinar parte del reservorio de respuestas de la asociación entre hongos micorrizógenos arbusculares (HMA) y una gramínea perenne, se estudió la respuesta de la inoculación de plántulas con HMA, bajo dos regímenes de riego seminal: húmedo y seco (capacidad de campo y la mitad del volumen de agua de ésta, respectivamente), sobre el desarrollo, supervivencia y tolerancia a la sequía de *Bouteloua gracilis* (*Poaceae*) en condiciones de invernadero. Las preguntas iniciales fueron: ¿Cómo influye la micorrización sobre el crecimiento de plantas de *B. gracilis* sometidas a estrés hídrico? ¿Las condiciones de humedad del sustrato influyen en la micorrización de raíces de *B. gracilis*? Al final del experimento se determinó el potencial hídrico foliar, cociente raíz/vástago (R/S), eficiencia del uso del agua (EUA), biomasa seca y húmeda, porcentaje de colonización micorrígena y la tasa de crecimiento relativo (TCR). Los resultados mostraron que los dos tratamientos húmedos tuvieron una respuesta significativa en crecimiento, en producción de biomasa y en supervivencia, respecto a los
testigos secos. Asimismo, la micorriza favorece significativamente el establecimiento y crecimiento de B. gracilis bajo condiciones de sequía. Se concluye que el tratamiento húmedo favorece significativamente la micorrización de un 40 a un 63%, que la antesis es función de la humedad y no de la micorrización y que en condiciones de capacidad de campo del sustrato, la micorrización incrementa la EUA en un 70%. Finalmente se recomienda micorrizar las plantas de esta gramínea en programas de repoblamiento vegetal de matorrales xerófitos deteriorados.

Recuperación de la cubierta vegetal del Parque Ecológico Cubitos, Pachuca, Hidalgo, México.

Monroy A., Arcadio; Esther Mariana García Amador, Roberto Ramos González, Rosalva García Sánchez, María Socorro Orozco Almanza
Facultad de estudios Superiores Zaragoza, UNAM

El Parque Ecológico Cubitos, ubicado en la ciudad de Pachuca, Hidalgo, es un Área Natural Protegida con categoría de Parque Estatal, en el cual se busca recuperar la cubierta vegetal constituida por matorrales xerófitos; para esto, se ha evaluado la tasa de erosión en sitios de ladera y planicie, se elaboró una matriz de plantas herbáceas y leñosas que constituyen los mosaicos de vegetación dominantes y se aplican técnicas de bioingeniería para favorecer el establecimiento vegetal como acolchados, geomallas orgánicas, posaderos y lechos de ramas. Asimismo, se realizó la identificación de 11 morfotipos de hongos micorrizógenos arbusculares (HMA) de los géneros: Glomus, Gigaspora y Acaulospora y se realizaron trasplantes del arbusto Mimosa biuncifera (gatuño), inoculado con HMA, bajo plantas nodrizas. Después de cuatro años, se ha logrado retenir la cubierta edáfica en parcelas experimentales, mediante barreras físicas en sitios con pendiente (4 cm en promedio) y se ha realizado la caracterización físico-química del suelo. También, se obtuvo una supervivencia anual del 92% de plantas de Mimosa biuncifera micorrizadas, bajo Opuntia cantabrigiensis. En los acolchados y lechos de ramas se han establecido especies nativas transplantadas en forma de mosaicos de vegetación. Por lo anterior se concluye que favoreciendo estrategias de establecimiento vegetal y de conservación edáfica es posible recuperar, aún parcialmente, la cubierta vegetal de este ecosistema semiárido.

Modelo de establecimiento de mosaicos de vegetación con riego por goteo medianteolla de barro enterrada para ecosistemas semiáridos deteriorados

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La rehabilitación ecológica de la vegetación debe considerar la estructura y distribución de plantas, para conformar mosaicos donde los individuos se complementan y aprovechan de manera óptima los recursos locales, como gremios. Por ello, se diseñó un modelo para establecer mosaicos vegetales en sitios deteriorados, consistente en un contenedor de hoja de palma, con una olla de barro poco cocido (tapada con tela de yute) y enterrada en el centro, la cual sirve de reserva hídrica para riego por goteo; el contenedor incluye 5 plantas, que coexisten naturalmente en matorrales xerófitos conservados, y que previamente fueron inoculadas con hongos micorrizados arbusculares nativos. Se construyeron dos modelos: a) un conjunto por mezquite (Prosopis laevigata) como planta nodrizas, asociado con las plantas crasas (cactáceas y agaváceas): Cephalocereus senilis, Agave lechuguilla, Opuntia senilis y O. microdasys y b) uno conformado por mezquite (P. laevigata) como planta nodrizas y por C. senilis, O. microdasys, A. salmiana y Mammilaria microhelia. Estos contenedores se pueden trasplantar a microcuenca o micrositios bajo arbustos, para repoblar sitios deteriorados. Se concluye que inducir mosaicos vegetales que coexistan naturalmente, facilita la formación de gremios ecológicos, gracias a la red hifal que conecta las raíces del conjunto de plantas y que esto es una ecotecnia útil de repoblamiento vegetal

Geocostales con pastos xerófitos: Una ecotecnia para el repoblamiento vegetal de ambientes deteriorados y para naturar azoteas

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Se desarrolló un modelo de geocostales a base de textil de yute, con sustrato 100% natural que incluye la combinación de tres especies de pastos xerófitos: Bouteloua gracilis (zacate navajita), B. curtipendula (zacate handerita) y Cenchrus ciliaris (zacate buffel). El geocostal contiene abono orgánico, micorrizas arbusculares, aserrín como retenedor de humedad y suelo de una zona semiárida. Este sistema se puede fijar (mediante estacas por ejemplo) en sitios con una capa delgada de suelo o sobre rocas, en la época de lluvias, con el objetivo de que se establezca una cubierta vegetal sin necesidad de riesgos suplementarios. Los geocostales pueden ser utilizados en zonas semiáridas deterioradas y para naturar azoteas de edificaciones impermeabilizadas y cubiertas con una
In the fall of 2010, the Port of San Diego began development of a Climate Mitigation and Adaptation Plan (CMAP) which will be an important tool for future planning and development of tidelands under their jurisdiction. It will help the Port identify, assess, and develop strategies which will help reduce greenhouse gas emissions and address local vulnerabilities to climate change. The CMAP will also focus on regional adaptation strategies pertaining to sea level rise, water reuse and efficiency, and beach erosion, as well as energy demand issues. The CMAP effort has begun to serve as a unifying process for a number of goals and objectives contained in related environmental programs conducted by the Port such as the Clean Air Program for criteria air pollutants, the Green Port Program for overall environmental and sustainability goals, as well as related utility energy efficiency programs. Tying together the mitigation and adaptation elements of a CMAP has also reached into more groups of the community during the stakeholder involvement – groups that may have questioned the advancement of one element without addressing the other. This paper will present progress to date on the CMAP including efforts to: • Develop baseline and future GHG

Índice de vulnerabilidad de la madera, un atributo a considerar en la selección de especies vegetales para proyectos de restauración ambiental

Montaño Arias, Susana Adriana; Sara Lucía Camargo-Ricalde, Rosaura Grether, Carmen de la Paz Pérez-Olvera

Diversas especies de Mimosa (Leguminosae) han sido reportadas con potencial para restaurar ambientes semiáridos, ya que forman islas de recursos, contribuyendo a la conservación del suelo y de la biodiversidad; sin embargo, se desconoce la vulnerabilidad de estas especies a la sequía. Se estimó la tolerancia a la escasez de agua de Mimosa bahamensis, M. hexandra, M. leucaenoides, M. luisana, M. polyantha, M. tejupilcana y M. tenuiflora estudiando los elementos vasculares. Se recolectó una troza del tallo (80 cm) a los 80 cm del suelo de tres individuos/especie. Se estimaron los Índices de Mesomorfia (IM) y de Vulnerabilidad (IV) mediante el número de poros/mm², el diámetro y longitud de los elementos de vaso. La madera tiene poros numerosos, solitarios, agrupados y múltiples; elementos de vaso cortos, de diámetro pequeño, con excepción de M. tenuiflora que tiene vasos de diámetro mediano y el mayor número de poros agrupados. Presentan un xílema mesófito y son poco resistentes al estrés hídrico. Según los escenarios del IPCC, durante el siglo XXI, la temperatura aumentará hasta 5°C, alterando el régimen de precipitación, por lo que se recomienda utilizar a M. luisana y M. leucaenoides en proyectos de restauración ambiental por presentar un IV menor, sugiriendo mayor resistencia a la sequía. Por otra parte, la presencia de poros agrupados se considera una ventaja en la conducción de agua al poderla redirigir, en caso de obstrucción de la columna de agua; sin embargo, M. tenuiflora, aunque presentó esta característica, resultó ser la más vulnerable a la sequía.

San Diego Unified Port District Climate Mitigation and Adaptation Plan

Moran, Laura

ENVIRON International Corporation

In the fall of 2010, the Port of San Diego began development of a Climate Mitigation and Adaptation Plan (CMAP) which will be an important tool for future planning and development of tidelands under their jurisdiction. It will help the Port identify, assess, and develop strategies which will help reduce greenhouse gas emissions and address local vulnerabilities to climate change. The CMAP will also focus on regional adaptation strategies pertaining to sea level rise, water reuse and efficiency, and beach erosion, as well as energy demand issues. The CMAP effort has begun to serve as a unifying process for a number of goals and objectives contained in related environmental programs conducted by the Port such as the Clean Air Program for criteria air pollutants, the Green Port Program for overall environmental and sustainability goals, as well as related utility energy efficiency programs. Tying together the mitigation and adaptation elements of a CMAP has also reached into more groups of the community during the stakeholder involvement – groups that may have questioned the advancement of one element without addressing the other. This paper will present progress to date on the CMAP including efforts to: • Develop baseline and future GHG
emission inventories for the Port and its tenants. • Review and rank control measures relevant to port operations including in the areas of energy and fuel efficiency, waste and water reduction, and alternative technologies. • Evaluate control measures to help the Port achieve its GHG emission reduction goals and develop tracking methods to evaluate the Port’s performance in meeting its goal. • Evaluate vulnerabilities of Port-managed land to potential effects (such as sea-level rise) from climate change and prioritize actions to address these vulnerabilities. Develop implementation strategies for addressing Port vulnerabilities to climate change.

**Estudio de la población de plántulas de Artocarpus heterophyllus, una especie exótica invasora presente en la reserva biológica de Dos Bocas, Espíritu Santo, Brasil**

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La invasión biológica también afecta las unidades de conservación. La Reserva Biológica de Dos Bocas, es un fragmento de floresta atlántica con un amplia área invadida por *Artocarpus heterophyllus*, árbol exótico de interés económico con elevada capacidad de producción de semillas. El presente trabajo llevó a cabo un estudio fitosociológico de las poblaciones de plántulas de *A. heterophyllus*, objetivando analizar su establecimiento e potencial de invasión en la reserva. Fueron alocados diez transeptos con diez metros de anchura y cien metros de extensión cada, divididos en diez parcelas con 10m x 10m; cada parcela tuvo cuatro su parcelas de 1m x 1m, con un total de 400 m² de muestreo. Todos los individuos con DAS abajo de 5cm tuvieron evaluados sus altura, frecuencia, densidad e dominancia absoluta y relativa, valor de cobertura e importancia. Cuando se analiza la frecuencia relativa de *A. heterophyllus* (47%), se entiende la urgencia de su gestión. Hay un predominio mayor de *Artocarps* en las tres primeras parcelas dos transeptos mientras que los transeptos ubicados en las mayores altitudes no presentaron plántulas de *A. heterophyllus*, pues la dispersión barocórica de sus semillas lleva a concentración de los individuos en logares de baja declividad. Así, se sugiere que el manejo de las plántulas de esa especie priorice las áreas más bajas de la Reserva, iniciando su sustitución gradual por especies nativas de la flora local.

**Metodología de nucleación para recuperación de un área degradada de restinga en el Parque estadual Paulo Cesar Vinha, Espíritu Santo, Brasil**

Moreira de Melo Silva, Henrique

Instituto Estadual de Medio Ambiente y Recursos Hídricos del Espíritu Santo

Técnicas de nucleación han sido muy empleadas en recuperación de ecosistemas impactados, elevando la eficiencia de la restauración ecológica por la formación de micro hábitats que sustentan la llegada de nuevas especies y aceleran la sucesión. Ese trabajo objetivó la implantación de la metodología de nucleación en área de extracción de arena en el Parque Estadual Paulo Cesar Vinha, región costera rica en biodiversidad. En 3,2 hectáreas fueron implantados 173 montes con 37 individuos cada, totalizando 6.401 tallos. Cada monte consistió de tres círculos concéntricos, conteniendo, en el círculo más interno, 5 especies nucleadoras (*Schinus terebinthifolius*, *Clusia hilariana*, *Kielmeyera membranacea*, *Senec australis*, *Guapira pernambucensis*), intercaladas con 4 bromelias *Quesnelia quesneliana*, que actúan como una cisterna, reteniendo agua. En el segundo círculo fueron implantadas 4 especies arbustivas no nucleadoras (*Jacaranda puberula*, *Capparis flexuosa*, *Swartzia apetala*, *Eugenia uniflora*, *Zizyphus platyphylla*, *Smilax rufescens*), intercaladas con 4 bromelias y 2 individuos de especies aleatorias (*Cereus fernambucensis*, *Pereskia aculeata*, *Neomarica northiana*, *Epidendrum denticulatum*, *Stachytagnetta canescens*) para elevar la diversidad de especies. El círculo más externo contenía 18 individuos de bromelias *Q. quesneliana* e *Bromelia antiacantha*, cuyos aguijones servirían como protección física. Se plantó en la estación lluviosa, utilizando polímero hidroretentor de acrilamida. Dados recientes demuestran que la mortalidad se cayó considerablemente, indicando la eficacia de esta técnica cuándo comparadas a otras tradicionalmente utilizadas.

**Orquídeas epífitas como indicadores biológicos en la restauración del Bosque Tropical, Tabasco, México**

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Como las orquídeas son excelentes indicadores de la calidad de vegetación por la importancia biológica y ecológica que tienen en la especificidad por su hábitat de ecosistemas naturales, se realizó un inventario de especies de orquídeas características de la selva para su conservación y manejo a través de una UMA con la comunidad de ejidatarios y asociación de mujeres del Ejido Villa Guadalupe, Huimanguillo, Tabasco. Se establecieron 10
transectos de 10 x 50 m² (0.25 ha). En donde se censaron todos los árboles con diámetro de la altura del pecho ≥ 3.18 cm y fueron marcados aquellos que hospedaban orquídeas epífitas. Con técnicas de ascenso árboles se llegó hasta el dosel. Se censó un total de 982 árboles contenidos en 34 familias y 154 especies. Se identificaron 66 árboles hospederos como: canshán (Terminalia amazonia), (Callophylum brasiliense), bellota (Sterculia apetala), caimitillo (Chrysophyllum mexicanum), guasano sangre (Lonchocarpus cruentus), laurel (Nectandra ambiguens), guayacan (Tabebuia guayacan), caobilla (Swietenia humilis), guapague (Dialium guianense), carne de pescado (Poulsea armata), palo colorado (Simira salvadorensis) y (Garcinia intermedia) Las especies orquídeas específicas de áreas no perturbadas son: Pleurothallis antonensis, Stelis guatemalensis, Scaphyglottis lindeniana, Maxillaria meleagris, Elleanthus carioídes, Oncidium ornithorhynchum, Isochilus alatus por lo que podemos considerarlas como indicadoras de la restauración de ecosistemas alterados.

An application of different methods of ecological restoration for riparian zones of reservoirs in Southern Brazil

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The reservoirs of hydroelectric plants require riparian vegetation to control erosion processes and to turn the areas more similar to natural ecosystems. In Southern Brazil, we are implementing an ecological restoration project to recompose forest ecosystems around the reservoir of the Machadinho Hydroelectric Plant, in the Uruguay River. The total riparian area comprises 1521 ha, but 90% is already covered by secondary forest. Just 10% (pasture or brushwood) is the focus of this project. They are subdivided in 297 areas, categorized by their size and forest proximity. According to these features, three methods with planting of native trees saplings (of circa 60 species) were established. The methods differ in intensity of planting and design: low (450/ha, in nucleus), medium (625/ha, in lines), high (900/ha, in nucleus), and control (without intervention). All areas were fenced to control cattle access. The planting began in October 2010 and in April 2011 the first monitoring was done, including evaluations of natural regeneration and sapling mortality. The results showed a higher regeneration density in the brushwood than in the pasture, without significant differences among the planting methods. Nevertheless, the no relationship among bush cover and regeneration density and the tendency of more individuals in the low treatment indicate an influence of the forest proximity. The mortality of saplings rate was higher in the pasture, with a tendency to increase in the medium method for both pasture and brushwood areas. We expect more differences between treatments in the course of time, especially for natural regeneration.

Especies de semillas dispersadas por monos aulladores (Alouatta prigra) en bosque conservado y en fragmentos de bosque en Palenque, Chiapas, México

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Universidad Nacional Autónoma de México

La dispersión de semillas por vertebrados es un proceso clave en la dinámica de la vegetación natural y en sucesión forestal de los bosques degradados. Mientras que los mamíferos grandes, especialmente los primates, son importantes dispersores de semillas en bosques conservados, ellos son usualmente raros en paisajes deforestado. Sin embargo, los monos aulladores debido a su flexibilidad de uso del hábitat, y al gran número de semillas que mueven dentro y entre hábitats, tienen una participación importante dentro de los procesos de dispersión de semillas en hábitats conservados y fragmentados. El objetivo del presente trabajo fue identificar las especies de semillas que son dispersadas por monos aulladores a través de sus heces en bosque conservado y en fragmentos de bosque. En total se registraron 40 especies de semillas en las heces de los monos aulladores, 27 especies en bosque conservado y 25 en fragmentos. Solo 12 especies de semillas se presentaron en ambos tipos de hábitat. La proporción de especies mayores a 0.5 cm en el bosque conservado y en fragmentos de selva fue del 74% y 68%, respectivamente. Nuestros resultados sugieren que la riqueza de especies de semillas dispersadas por aulladores varía según la condición del hábitat. Esta información es útil para promover la restauración bajo la premisa que la conservación de los dispersores servirá para acelerar los procesos de sucesión en los bosques tropicales.

El efecto de las especies leñosas, en la recuperación natural de los suelos posterior al uso ganadero en la región de Chamela Jalisco, México

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La conservación del bosque tropical seco es importante por lo que es necesario poner atención a los aspectos relacionados con la perturbación, para generar alternativas de manejo. En la zona de BTS de Chamela Jalisco no se sabe el papel que juegan algunos grupos funcionales de plantas, como las leñosas, en la dinámica de nutrientes y en los patrones de fertilidad o en la restitución de procesos del suelo. En este contexto es importante evaluar los cambios en el suelo ante un escenario común en la zona, donde se dejan crecer las especies leñosas, y se frena con el pastoreo. Una manera es contando con indicadores edáficos, que muestren de manera temprana los cambios sufridos en el tipo de manejo. En este trabajo se evaluaron los cambios en el suelo perturbado, ante la presencia de especies leñosas y el cese del pastoreo. Se evaluó el efecto de los diferentes tipos de manejo con la disponibilidad de nutrientes en forma de amonio, nitratos y fosfato disponible. Así como su relación con la actividad de enzimas relacionadas con el ciclo del C, N y P. También se evaluó la agregación del suelo, la biomasa de raíces, la materia orgánica y la biomasa microbiana, se midieron en el suelo como indicadores de su calidad. De acuerdo con los indicadores de suelo evaluados se observó que las condiciones en el tratamiento sin pastoreo y con cese de vegetación arbórea y herbácea son favorables en la restitución del ciclo de nutrientes y de biomasa microbiana. Mantienen una mejor estructura y se promueve la formación de materia orgánica.

**Establishment of planted woody species in recovery areas of riparian Atlantic Forest in a micro-watershed in the State of Rio de Janeiro, Brazil**

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Universidade Estadual do Norte Fluminense

Rural practices generally cause changes in the environment that affect water resources. Options for mitigation strategies to reverse this situation are the topic of many discussions. The Rio Rural/GEF project has implemented actions for the recovery of water bodies by investing in the restoration of riparian vegetation in rural communities. This study aimed to evaluate the establishment of planted seedlings 26 months after transplantation in four rehabilitation areas in private lands in the Brejo da Cobiça micro-watershed. The selected areas had 30x100 m and seedlings were planted with a spacing of 3x1.5 m, with height varying from 30 to 100 cm. Pioneer species were planted six months earlier than secondary species. After 26 months, seedlings had their total height and basal diameter measured. The number of live seedlings per plantation (33-365) indicated a high mortality (45-95%). Average height varied from 58 cm to 2.25 m. Seventeen non-planted individuals from nine species were registered. Some exotic species such as, *Acacia mangium*, *Azadirachta indica*, *Gliricidia sepium* and *Tamarindus indica* were sampled, indicating that indigenous seedlings were not the only species used in the plantation. The high mortality values found seem to be related to a lack of permanent isolation of the areas to prevent grazing by cattle and to the clearing of tree pits. The results reinforce the need for technical assistance and support incentives for the rural producer that promotes the use of environmental management practices.

**Structure and floristic composition of a corridor in the Brazilian Atlantic forest after 14 years of planting**

**Nascimento, Marcelo; Marcelo Paixão Reis, Carlos Alvarenga Junior**

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The Atlantic Forest has suffered severe degradation due to deforestation. The loss of connectivity among landscape units by fragmentation causes changes in plant and animal communities by promoting loss of habitat for many species. Forest corridors have been used to establish connection between fragments. The aim of this study was to evaluate the structure and composition of a forest corridor planted in 1998. The corridor has an area of 0.75 ha (30x250 m) and 1250 seedlings belonging to eight species were planted at spacing of 3x2 m. Seedling establishment was assessed in March 2011 in 25 plots of 30x10 m. All trees with DBH ≥ 1.6 cm were tagged and measured. A total of 254 individuals from 37 species (29 spontaneous) were sampled. Planted seedling establishment was lower than 10%. Average height and tree density varied amongst plots, plots 1 to 7 (28% of plots) presented an average of 7 m and 15.3 ind./plot, the others showed an average height of 4 m and 8.2 ind./plot. The lower number of individuals and smaller stature of plants in these plots seems to be associated with river flooding during the rainy season and the presence of exotic grasses such as, *Brachiaria* spp. and *Imperata brasiliensis*, which cover almost the entire soil surface. The low establishment of planted seedlings, even in plots 1-7, seems to be related mainly to seedling damages suffered from grazing animals in 1998-2004: a period during which the corridor was without fences.
Creating habitat on urban green roofs

Keith Nevison

Consciously-designed green roofs can be a useful tool in urban restoration ecology. As cities expand outward, the installation of green roofs on buildings can serve as surrogate habitat for native plants and animals displaced by development. Green roofs can also serve as refuges for rare and endangered species, facilitating their recovery and recolonization into impacted landscapes. Strategic location of green roofs can improve access corridors for species migrating through the urban landscape. Here at Portland State University, we recently witnessed native, ground-nesting juncos (Junco hyemalis oreganus) successfully fledge their young on campus green roofs. My research is focused on re-vegetating green roofs with native, endemic plant species, and integrating organic matter into existing soilless substrates. Until now, green roof materials have centered on lightweight mixes that are easy to install, without adding excessive engineered loads to buildings. Unfortunately, these barren substrates lack qualities that...
make them suitable for habitat, and are primarily installed to conform to LEED green building certification requirements. Re-integrating organic matter to create extensive-intensive hybrid substrates can be an effective tool to increase moisture retention, nutrition, and the overall character of rooftop habitat. By selecting native species for the rooftop, we can create landscapes that resemble the local environmental conditions in surrounding ecosystems (e.g. Willamette prairie, Eastern Oregon desert).

Análisis de la relación de grupos bentónicos y variables ambientales ante potencial fragmentación de hábitat y disturbio antropogénico en el sistema estuarino Términos-Sabancuy, México

Nuñez Lara, Enrique; Benito Calderón Cruz, Roberto Brito Pérez, Ángel Alderete Chávez, Daniel Pech Pool
Universidad Autónoma del Carmen

Se investigó la estructura de la comunidad macrobentónica en un sistema estuarino sujeto a una dinámica natural de flujo hídrico, transporte de sedimentos y conectividad. El sistema Términos-Sabancuy en la costa sudoccidental de la Península de Yucatán, esta sujeto a un creciente impacto por actividades humanas pese a estar en un área natural protegida. Los objetivos fueron: i) reconocer patrones de respuesta ecológica de la comunidad macrobentónica a variables ambientales y ii) evidenciar efectos antrópicos que invoquen estrategias de conservación o restauración. Se recolectaron muestras de la comunidad macrobentónica y se midieron parámetros físicos, químicos y biológicos en agua y sedimento. Se analizaron los patrones de distribución, abundancia, densidad y diversidad de grupos bentónicos en 32 estaciones de muestreo y se realizaron pruebas de regresión múltiple para relacionar descriptores de la comunidad y variables ambientales. Los cuatro grupos más importantes identificados fueron poliquetos, bivalvos, gasterópodos e isópodos. Los mapas de distribución mostraron la ausencia de un patrón en la abundancia y densidad asociada al flujo hídrico, indicando posible fragmentación del hábitat. Los patrones de variación espacial de los grupos bentónicos y de la relación de éstos con los parámetros ambientales evidencian influencia antropogénica en el ecosistema. Poliquetos y gasterópodos fueron más abundantes en las estaciones cercanas a las bocas que conectan con el mar – cerca de los poblados. Asegurar la comunicación natural de elementos bióticos y abióticos en el estuario debe ser prioritario en los planes de manejo y desarrollo. El presente estudio aporta evidencias importantes en ese sentido

Response of macroinvertebrate communities to the changes in the habitat structures of a restored stream: A case study of the Kwacza River (N Poland)

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Past stream channelization and construction of weirs and other obstructions has considerably altered the Kwacza river, a tributary to the Słupia River (N Poland) and hindered the free passage of salmonid fish and stream macroinvertebrates. To improve floodplain connectivity, in 2007, a project “Protection of Atlantic salmon and migratory trout spawning grounds in the Słupia river basin” was implemented. Its first stage called “The Kwacza Restoration Project” included the construction of 68 in-stream structures (LWD, boulders, culverts, groyne, deflectors) and reconnection of isolated habitats along 2.5 km of the watercourse. The study was carried out to reveal the macroinvertebrate structure and its reaction on the changes in hydraulic and hydrochemical conditions along the restored channel of Kwacza River. Biotic indices (BMWP-PL, ASPT, OQR) as well as River Morphology Hierarchical Classification were applied to assess ecological status and microhabitat conditions in the restored stream. Apart from biomonitoring, morphological and hydrochemical measurements were performed and BACI effect calculated. Results showed the highest ecological values of the microhabitats soon after their construction. Stabilized bank conditions (fascine) were dominated by Ephemeroptera and Trichoptera larvae. LWD or boulder placement has been settled by the Crustaceans mainly. Ephemeroptera, Trichoptera and Diptera larvae dominated at groynes, while Bivalvia and Crustacea favoured deflectors. Instream boulders were dominated by Diptera, Ephemeroptera and Crustacea larvae. The reconnection of former meanders promoted the development of all macroinvertebrate communities, among which Ephemeroptera larvae showed the highest values of biotic indices.

Evaluation of indicators for monitoring forest restoration in the Brazilian Atlantic Forest

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São Paulo State University

Choosing an adequate set of indicators is a key to monitoring restored ecosystems. The aim of this study was to evaluate a set of indicators, and their effective use and validation by stakeholders in the processes of restoration in the Brazilian Atlantic Rainforest in different phases. Based on scientific studies, a list with 53 indicators was
elaborated, specifically to the evaluation of forest restoration projects in this biome. The indicators were categorized into physical and structural, biodiversity, environmental services and ecological processes, economic and social indicators. After that, stakeholders have been identified in several states and in several Brazilian institutions. They were asked to rate the importance of the indicators listed (ranging from 0 to 3) at different stages of forest restoration (initial = 2 to 3 years; short term = 10 years; medium term = 10 to 50 years; long-term = more than 50 years). According to the stakeholders, considered actors in the restoration processes, in the initial phase, the highest average scores were given to social indicators and economic indicators. High scores refer to the degree of acceptance and local community participation in the drafting and implementation of a restoration project and the costs of developing, deploying and maintenance of restoration projects. In the following stages, indicators of biodiversity are considered most important, followed by other ecological indicators (indicators related to environmental services and ecological processes). The structural and physical indicators are more important on the initial term and short-term, than in the later stages in the restoration process.

Identifying ecological filters in restoration activities in temperate and tropical forests

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Environmental filters might be a way to compare restoration activities in different ecosystems, located in different regions and situations with more or less similar degradation. We selected articles that presented or discussed the restoration of forest ecosystems, from 1980 to 2008. These actions were analyzed and categorized according to the twelve categories of environmental filters (biotic and abiotic) proposed by Hobbs & Norton (2004) and Nuttle (2007). We analyzed 105 studies published from 1980 to 2008, which referred to the restoration of forest ecosystems in 23 countries. Of the 105 articles, 16 (15%) did not allude to specific filters, or describe restoration actions, 3 cited or were related to only abiotic filters, and 31 referred to both categories of filters. The majority of them (44 articles) refers to biotic filters. In the articles reviewed, the most cited among abiotic filters was the landscape structure. Among the biotic, the pool of species is present in 31% of articles. When analyzing only restoration actions in the tropics (26 articles), important filters were the order of species arrival and the propagules availability (35% and 30% of the articles, respectively). Both are related to the potential for natural regeneration and successional processes, which are fundamental to the functioning and dynamics of tropical forests. The species interactions (especially competition and mutualism) are debated in many studies (43% of analyzed here), being also an important filter to be focused on in tropical forest restoration.

Implementación de cultivo in vitro de cactáceas de zonas semiáridas de Jalisco como técnica de restauración ecológica

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Universidad de Guadalajara

Las regiones semiáridas de Jalisco presentan amplia diversidad de Cactaceae; sin embargo, múltiples factores ambientales y antropocéntricos ocasionan disminución de riqueza y distribución de especies, tal es el caso de Mammillaria densispina y Stenocactus multicostatus, importantes en los ecosistemas de estas regiones, no obstante los primeros meses de vida son críticos para constituir una planta adulta. Por lo anterior, nuestro objetivo fue implementar una técnica de cultivo in vitro con la finalidad de incrementar sus poblaciones con ejemplares potenciales para recuperación de suelos. Se germinaron semillas de Mammillaria densispina y Stenocactus multicostatus, para obtener plántulas como fuente de explante, se sembraron en medio MS con hormonas ANA (0.1 mg/L, 0.01 mg/L y 1 mg/L) y BAP (1 mg/L, 0.5 mg/l) y 1.5 mg/l de antioxidantes: ácido cítrico, ácido ascórbico y PVP; se mantuvieron a 16/8 hrs de fotoperiodo, temperatura 24°C y 1000 lux. Se evaluó la tasa de germinación de semillas in vitro, crecimiento de explantes, presencia/ausencia de callo, raíz y brotes. Los resultados demostraron que las plantas generadas con este método presentan crecimiento y desarrollo favorable, con índices bajos de contaminación (3%); su apariencia es turgente, verde, tubérculos con numerosas espinas. Se concluye sobre la eficiencia del método aplicado como técnica para la regeneración de cactáceas, su conservación e importancia en procedimientos de restauración ecológica.

UNU land restoration training programme: Capacity building in developing countries

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The UNU Land Restoration Training programme (UNU-LRT) offers training in ecological restoration of degraded lands and sustainable management of ecosystems. The training is custom-built for professionals in developing countries with the aim to strengthen institutional capacity and to empower women working in this field. UNU-LRT offers annually a six-month training course in Iceland. The first half of the six-month training course is dedicated to course work, practical training and demonstration of different land use practices and conservation work. In the latter half of the training, the focus is on individually based project work, which is tailored to the academic and practical background and needs of the individual professionals and their institutions. The project work is completed by submitting a comprehensive written report and delivering oral presentation at an open seminar at the end of the six-month training. The UNU-LRT programme and the training it offers is built on the wide ranging experience and knowledge gained within Iceland through century long efforts to halt land degradation and repair and restore damaged land.

**Valoración del estado ecológico del corredor fluvial en la cuenca del río Ayuquila-Armería, México: Estrategias para su conservación y restauración**

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Universidad de Guadalajara-CUCSur

La cuenca del río Ayuquila-Armería es una región de interés hidrológico y conservación de la biodiversidad. Se ubica en la confluencia de dos provincias fisiográficas, amplio rango altitudinal (2 a 2000 msnm), topografía accidentada y complejidad geológica. El objetivo del estudio es la valoración de la estructura y dinámica del funcionamiento del corredor fluvial en la cuenca, así como del análisis de las presiones de uso y manejo. A través de la aplicación del RQI (Riparian Quality Index), que considera los siguientes atributos: condiciones hidrológicas, continuidad longitudinal, dimensiones del espacio ripario, conectividad transversal, condición de las orillas y regeneración natural. Se evaluaron 67 tramos fluviales (de 500 m, a lo largo del corredor ripario), incluyendo los cauces permanentes y principales corrientes tributarias en la cuenca. Si bien, la vegetación leñosa de la ribera mantiene cierta conectividad lateral y longitudinal con su cauce, es poco densa y estrecha. Esta dominado por Salix humboldtiana y S. bonplandiana, frecuentemente asociada con S. taxifolia y Phitecellobium dulce (especie asociada a sitios con intensivo pastoreo de ganado). La regeneración natural con amenaza moderada a severa por el pastoreo, actividades agrícolas, regulación de caudales, alteración de las orillas ó márgenes y extracción de materiales del lecho del río. Se discuten las implicaciones de la valoración del estado ecológico para la conservación y restauración de las riberas.

**Effect of nutritional regimens on seedling quality in Quillaja saponaria (Mol.): Implications for post-planting survival in semiarid Mediterranean ecosystem of Central Chile**

Ovalle Ortega, Juan Francisco; Eduardo Carlos Arellano O gaz

Pontificia Universidad Católica de Chile

The use of native trees for compensation and forest restoration purposes has increased significantly during the last decade. Among these trees, Quillaja saponaria (Mol.), endemic to Central Chile, has been one of the most used. However, high mortality following planting due to low seedling quality, reduces the normal establishment of this species across Mediterranean semi-arid areas of Central Chile (32° - 33° S latitude, 71° S longitude). This situation affects the forest compensation goal, which is at least 75% survival at the end of the second year following planting. In order to improve seedling quality and survival, the objective of this work is to evaluate, during one growing season, the effect of the use of controlled-release fertilizer (CRF) on root growth potential, nutritional content and localization in tissues and photosynthetic efficiency. Preliminary results show that treatment with CRF affected root volume, leaf nutrient content and photochemical efficiency, compared to conventional fertilizer. The results could be attributed to a lower electrical conductivity in the rhizosphere with CRF treatment, allowing further growth of the root system. The development of seedling quality and field performance attributes could increase the survival and initial growth rates under drought conditions.

**Evaluación del uso de especies nativas del bioma Cerrado en siembra para la restauración de áreas degradadas**

Pegorini Bordini, Michelle Carmelinda; Amanda Caldas Porto, Clarissa María de Aguilar, José Roberto Rodrigues Pinto, Alvaro Nogueira de Souza, Carmen Regina Mendes de Araújo Correia, Christopher William Fagg

Universidad de Brasilia
Denitrifying bacterial community patterns of wetland soils by T- RFLP and qPCR in created and natural wetlands

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Denitrification is one of the key ecological functions of natural wetlands extensively studied. Denitrifying bacteria play a significant role in the denitrification function of wetlands due to their ability to convert nitrate to gaseous N₂. Denitrifying bacteria can best be described as a group of bacteria that have the ability to produce dissimilatory enzymes that reduce NO₃⁻. Numerous studies have investigated the factors controlling denitrification in an attempt to better understand the process, mostly focusing on the roles of NO₃⁻ availability, O₂, and pH. These are the key regulators of denitrification rates at any particular instance. Recently, the assumption that the composition of the denitrifying community is of minor importance in controlling denitrification has been challenged. It is suggested that communities vary in their tolerances to environmental conditions and stresses. Therefore, denitrifying bacterial community may act as a medium through which environmental controls on denitrification are realized. However, little is known about the relationship between bacterial community composition and denitrification process. The objective of this study was to investigate denitrifying bacterial community patterns in three created and two natural wetlands in the Piedmont region of Virginia. Bacterial community composition and diversity data showed significant differences by soil physiochemical conditions, hydrology, and age of wetlands (i.e., for created wetlands). Further analysis results will be presented.
Are differences in understory diversity in Atlantic Forest restoration sites due to nearby landscape?

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Reforestation with native species can facilitate natural succession in altered landscapes and the distance from seed sources can influence this process. To analyze the influence of nearby landscape structure on the native plant species regeneration, we studied 16 areas reforested with similar ages at different distances from forest patches. In each area ten 10x10m plots were sampled, where all woody plants greater than 10cm were recorded. The abundance of native late successional trees showed a significant relationship with all landscape structure variables used, with a higher correlation with the proportion of native vegetation in a 1km radius (regression, $r^2=0.49$, p<0.001). (Zoochoric species abundance showed a weak relationship with the plot distance from forest fragments (regression, $r^2=0.024$, p=0.05)). All forms of species richness (total, zoochoric, native, native trees and late successional trees species richness) correlates with landscape structure variables (distance to forest patches; vegetation proportion in a 1km and 500m radius) and zoochoric species richness showed the highest correlation (Spearman, $r=0.48$, p<0.05). We concluded that landscape structure at distances up to 1km from reforestations influence species richness and abundance, thus considering amount of remnant habitat in immediate area around restoration sites is crucial.

Germinación y desarrollo inicial de árboles tropicales nativos en suelo contaminado con petróleo crudo nuevo e intemperizado en Tabasco, México

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El Colegio de la Frontera Sur

Los suelos contaminados con petróleo se caracterizan por su baja o nula productividad agropecuaria, una opción viable es propagar arboles tolerantes al petróleo que den beneficios a los pobladores y a largo plazo mejoren la fertilidad del suelo. Con base a su utilidad local se seleccionó para el experimento a Cedrela odorata, Guazuma ulmifolia, Haematoxy lum campechianum, Swietenia macrophylla y Tabebuia rosea. En invernadero se evaluó la germinación y crecimiento aéreo en suelo contaminado con petróleo crudo nuevo pesado en tres concentraciones, 25000(T1), 50 000(T2) y 75 000(T3) mg kg$^{-1}$ y un suelo con petróleo intemperizado con 60000 T4 mg kg$^{-1}$. En cada unidad experimenta con capacidad de 4 kg se sembró 30 semillas de la misma especie con cuatro repicas por tratamiento. T. rosea, H. campechianum y C. odorata, iniciaron el proceso de germinación en T4, estas especies presentaron alta proporción de semillas germinadas, no mostraron diferencias significativas entre los tratamientos y el testigo. S. macrophylla y G. ulmifolia no han germinado. El crecimiento de T. rosea y H. campechianum es mayor en el T4 y el T2, el crecimiento es más uniforme en el T1 y el testigo. La mortalidad ha sido nula para todas las especies. Estos árboles son de gran utilidad para la población local y al ser tolerante al petróleo tienen gran potencial para ser propagados en suelos contaminados con hidrocarburos que son pocos productivos, además de ser especies potenciales para degradar el petróleo y restaurar la fertilidad del suelo.

Propagation trials of some tree species suitable for rehabilitation of La Lejia microbasin, Cundinamarca, Colombia

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Universidad Distrital Francisco José de Caldas

Propagation trials were conducted on 13 tree species considered in previous studies as suitable for rehabilitation of the La Lejia microbasin in Cundinamarca, Colombia. Studied species were Guadua angustifolia (guadua), Trichanthera gigantea (madre de agua), Tabebuia rosea (ocoboo), Cordia alliodora (nogal cafetero), Croton spp (drago), Erythrina edulis (balú), Persea americana (aguacate), Cedrela montana (cedro de altura), Cedrela odorata (cedro rosado), Ficus spp (caucho), Ficus carica (brevo), Psidium guajava (guayaba) and Solanum betaceum (tomate de árbol). In three community nurseries we evaluated the response of seeds, rescued seedlings and hardwood cuttings in five substrate types (i.e. 1. soil, 2. soil and organic fertilizer, 3. soil and rice husk, 4. soil and a microbial mixture, and 5. all types combined). Species response was measured during three months in terms of germination/survival percentage and changes in leaf number and seedling height. The results showed that survival and growth were significantly higher in soil and organic fertilizer and soil and rice husk for any propagation type. The best performance was exhibited by Cedrela montana and Erythrina edulis. We highlight the importance of community

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Propuesta de restauración ecológica participativa vereda Mancilla- Facatativá (Colombia)

Pinzón García, Eder Guillermo; Sergio Andrés Collazos González, Leiber Mendoza, Andrés Felipe Moreno Romero

Fundación le-Sua

El proyecto se desarrolla en la Vereda Mancilla (Facatativá - Colombia) en una zona de bosque seco y húmedo montano bajo. En esta región se han presentado alteraciones por la conversión del ecosistema, a través de entresacadas y tumbas, en un “archipiélago” de relictos boscosos inmersos en una matriz agropecuaria que amenaza con expandirse y continuar la fragmentación de la comunidad forestal nativa. Se busca generar conciencia ambiental a través de talleres de sensibilización y capacitación en temas ecológicos, de manera coherente con los procesos antropológicos de nuestra herencia musica cuya cosmovisión se sustentaba en el respeto y equilibrio con la naturaleza. Se fundamenta en un diagnostico biofísico a partir de la identificación de patrones de uso del suelo, tensionantes, limitantes, barreras para la restauración y el potencial de regeneración (fase de la ecología, fisonomía, composición y estructura del bosque), para definir una línea base del estado actual y el estado deseados posible. El proyecto gestiona actualmente la conformación de un comité ambiental veredal como escenario para la vinculación activa de la comunidad y establecer así el modelo de restauración en las fincas aledañas al área de estudio, de manera que se conecten y promover las dinámicas de la biocenosis endémica a través de un corredor biológico. A la fecha se ha realizado una jornada de recolección de residuos sólidos, revegetalización de humedal y arborización de la escuela Vereda Mancilla.

Análisis morfo-functional de plántulas para la selección de especies útiles en la restauración de bosques secos tropicales

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Universidad Nacional Autónoma de México

Los bosques secos están entre los ecosistemas más transformados, y aun es limitado el conocimiento sobre los procesos de regeneración natural, y las especies potencialmente útiles para restaurar sitios degradados o acelerar procesos sucesionales en bosques secundarios. Se evaluó la variación morfo-functional de plántulas de 41 especies arbóreas del bosque tropical seco dominantes en distintas etapas de la sucesión secundaria en la región de Chamela, Jalisco. Se caracterizaron los gradientes de variables físicas y recursos a lo largo de la cronosecuencia, y se exploraron correlaciones con 13 variables morfológicas relacionadas con la respuesta de las plantas a la variación en estas condiciones. Se buscaron atributos indicadores de estrategias exitosas en los diferentes ambientes, que permitan definir grupos funcionales de especies potencialmente útiles en esfuerzos para restaurar zonas degradadas, y para acelerar la sucesión secundaria. Se encontraron tres tipos de estrategias relacionadas con el uso de recursos, principalmente el agua: especies almacenadoras, tolerantes y explotadoras, siendo los atributos relacionados con el contenido de agua o densidad de los tejidos, y aquellos que expresan la relación entre superficie y masa de hojas y raíces, los más útiles para identificar estas estrategias. Se sugiere que las especies almacenadoras y tolerantes son útiles para acelerar la recuperación de la biodiversidad a partir de escenarios extremos, como predation abandonados, mientras que las especies explotadoras serían útiles para enriquecer etapas tempranas e intermedias de la sucesión.

Establecimiento de Juncus effusus y Cyperus rufus en zonas invadidas por Cucurbita ficifolia en la franja inundable y terrestre del humedal Juan Amarillo (Bogotá D.C.)

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Universidad Nacional de Colombia

Cyperus rufus y Juncus effusus son dos especies nativas de los ecosistemas de humedales en Bogotá D.C. La primera ha sido reportada como vulnerable, y la segunda no es representativa en los humedales de Bogotá D.C. En el humedal de Juan Amarillo, se cultivó Cucurbita ficifolia (especie nativa, colonizadora agresiva) para desplazar a Pennissetum clandestinum (una invasora agresiva). En este humedal se establecieron 24 parcelas experimentales de 1mx1m, distribuidas en cuatro bloques ubicados a lo largo de un gradiente terrestre-inundable; en cada bloque se sembraron tres individuos de Juncus effusus y tres de Cyperus rufus (uno por parcela), donde cada individuo por especie recibió un tratamiento distinto a saber: (1) la calabaza (Cucurbita ficifolia) fue retirada de raíz, (2) la calabaza se picó, y se dejó la biomasa cubriendo el suelo, (3) la calabaza se dejó intacta. Con el fin de observar el comportamiento de las especies sembradas frente a una invasión de calabaza, se tomaron datos mensuales para evaluar el crecimiento y desarrollo fenológico de las especies a evaluar, así como la persistencia de la especie.
invasora establecida. Se observó la reaparición de *Pennisetum caldendarum* y la germinación de *Ricinus communis*, donde se retiró la calabaza (especies invasoras en los humedales de Bogotá D.C.). La respuesta de las especies evaluadas fue positiva en el plano inundable, pero fueron incapaces de competir con la calabaza en el plano terrestre. Los tratamientos 1 y 2 favorecen el desarrollo de las especies evaluadas.

**Earthworm assemblages on afforested colliery spoil heaps as affected by tree species**

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Academy of Sciences of the Czech Republic

Earthworm assemblages were analysed at twenty-eight colliery spoil heap sites of similar age located in the Sokolov open-cast coal mining district, Czech Republic. Sites afforested with different tree species, namely spruce, pine, larch, oak, lime, and alder, were selected for the study in four replicates each, and compared with un-reclaimed sites covered with spontaneously developed vegetation. No difference was found in the density of earthworms between un-reclaimed sites and coniferous stands, however, a significant effect of tree species on worm density was observed at sites with deciduous afforestation. Dense earthworm populations developed in alder and lime plantations, while worm density was significantly lower under oak. Similarly, earthworm biomass at sites with coniferous afforestation did not differ from that of un-reclaimed heaps and was significantly lower than those at sites with deciduous afforestation. Both density and biomass of earthworms were positively correlated with the contents of soil organic matter and available potassium, and with the mass of the fermentation layer, and negatively correlated with the depth of the fermentation layer. At un-reclaimed sites, only two earthworm species were found. At the afforested sites, species richness was higher, ranging from 4 in larch to 7 in alder plantations. The density of endogeic species was negatively correlated with soil pH and depth of fermentation layer, and positively with soil organic carbon, available potassium and the mass of fermentation layer, while the epigeic earthworms showed only preferences for the soil organic matter and the mass of fermentation layer.

**Propagación por semilla de especies de importancia económica y agroforestal (*Psidium guajava* L. y *Tamarindus indica* L.): Contribución a su conservación y propuestas para restaurar tierras semiáridas**

Ramírez Guillén, Karelly Hasanya  
Universidad de Guadalajara

Con la evolución del concepto “agricultura sustentable” se han utilizado sistemas agroforestales, que incluyen árboles como tamarindo (*Tamarindus indica* L.) y guayaba (*Psidium guajava* L.), de gran interés debido a sus cualidades multipropósitos, amplio margen de adaptación y capacidad de producción. El objetivo de este trabajo fue investigar la respuesta germinativa in vitro y en invernadero de semillas de estas especies utilizando métodos físico-químicos: escarificación mecánica (tallado de semillas con lija), inmersión en agua caliente a diferentes temperaturas, remojo en agua destilada, inmersión en soluciones de NaCl, H2SO4 y ácido giberélico en diferentes concentraciones. Se utilizaron tres repeticiones de 50 semillas por tratamiento, para cada especie aplicando un diseño completamente al azar. Los resultados demostraron que el tratamiento de escarificación mecánica es más eficiente para promover la germinación de semillas de guayaba a 8 días de inicio del experimento con 100 % de germinación; curvas de crecimiento y desarrollo favorable de las plántulas provenientes de dichas semillas, mostrando porcentajes altos de supervivencia (80 %). En el tamarindo ninguno de los tratamientos influyó en la respuesta germinativa; sólo la adición de NaCl 120mM promovió el desprendimiento de la testa de la semilla a los seis días del experimento, pero sin emergencia de la radícula. Se concluye sobre la posibilidad de incluir a *Psidium guajava* en procedimientos de propagación y conservación de especies agroforestales.

**Efecto de las plantaciones de palma aceitera sobre la lluvia de semillas y el establecimiento de plántulas, en la cuenca del río Curbaradó, Chocó (Colombia)**

Ramírez Herrera, Johanna; Cristina López Gallego  
Universidad de Antioquia

Al cesar las perturbaciones en los bosques se inicia un proceso de sucesión natural cuyo curso dependerá, entre otras cosas, de las condiciones iniciales del sitio. Evaluamos el impacto que tienen los monocultivos de palma aceitera sobre la regeneración natural de los bosques en la cuenca del río Curbaradó, enfocándonos en dos procesos: la lluvia de semillas y el establecimiento de plántulas. La riqueza de especies en los dos procesos fue menor en las plantaciones; la composición de especies de la lluvia de semillas en las plantaciones fue ligeramente diferente a la de
los bosques, mientras que para la comunidad de plántulas las plantaciones no se diferencian claramente de las otras unidades de paisaje. La riqueza promedio de especies fue menos variable, y la similitud en la composición de especies fue mayor entre las plantaciones que entre los rastrojos y entre los bosques. Estos resultados sugieren que estas plantaciones no representan una barrera significativa para la lluvia de semillas y el establecimiento de plántulas en los estados iniciales de la sucesión, sin embargo los efectos observados sobre la riqueza de especies y la homogeneidad en la composición y riqueza de especies en la lluvia de semillas y el establecimiento de plántulas entre las plantaciones, a largo plazo podrían incidir sobre el curso de la sucesión natural, lo que debe tenerse en cuenta al momento de diseñar un plan de restauración.

Quantifying forest resources in restoration: Importance of accurate timber products estimation
Ré, Danilo Scorzoni; Vera Lex Engel, Liz Miyo Sousa Ota
Sao Paulo State University

The success of forest restoration is, in most cases, related to the economic benefits that this activity can generate to the farmers, especially those who depend totally on land incomes for their subsistence. Within this context the management of restored areas, allowing the use of multiple forest products, becomes an important ally for forest restoration success. Therefore, the correct estimation of forest resources using appropriate statistical tools becomes essential. The aim of this study was adjusting allometric equations for estimating height and volumes of different tree species at several alternative systems for forest restoration through regression analysis. The research was carried out at Botucatu County, Sao Paulo State, Southern Brazil. We measured tree diameters at different heights using a Wheeler’s pentaprism to quantify the volume and height of 10 tree species -belonging to fast or slow growth groups, planted in four systems of different species composition and spatial arrangements. The hypsometric equations fit indicated moderate relation between diameter and height ($R^2 = 0.71$, p-value <0.001) and high relation between diameter and volume ($R^2 = 0.98$, p-value <0.001). The adjusted model met the assumptions of linear model: normality, constant variance and non-correlation of the residuals. The use of these equations will be a key to the correct estimation of forest products and thus evaluating yield and the potential economic income of these systems.

Change in sedimentary organic carbon content during mangrove restoration using carbon isotopic measurements in Southern China
Ren, Hai; Jingping Zhang, Chende Shen, Zhongyu Sun, Jun Wang
Chinese Academy of Sciences

Based total C and C isotopes in sediment cores, sedimentary organic carbon (SOC) was quantified in three kinds of mangrove sites (barren flat sites without mangroves, mangrove plantations, and natural mangrove forests), which were considered to represent a continuum from least restored to most restored sites in Southern China. We inferred that mangrove restoration increases SOC content because SOC contents in the barren sites, plantations, and natural forests were 90, 170 and 288 Mg ha$^{-1}$ respectively. In both kinds of mangrove sites but not in the barren flat sites, the enrichment of $\delta^{13}$C with depth has been related to increases in SOC decay and SOC age with depth. The sediments of mangrove forests in Southern China sequester large quantities of organic C.

Restauración ecológica, una medida de mitigación ambiental en construcción de autopistas
Riaño Ramírez, Noel
Ojo de Agua

Es importante que desde la concepción y diseño de un proyecto carretero se tengan en cuenta la realización de medidas de mitigación ambiental para minimizar los impactos negativos. La restauración ecológica es una de ellas para recuperar sitios afectados por las actividades de construcción y disminuir el efecto de fragmentación que ocasiona una obra de tipo lineal. Para la planificación de la restauración ecológica es importante primero revisar los términos y condiciones legales bajo las cuales fue autorizado ambientalmente la autopista, sus características geométricas y las características físicas, biológicas socioeconómicas del área de interés. Después se procede a la definición, cuantificación y ejecución de actividades, por ejemplo: rescate de plantas y animales, obras de conservación de suelo, producción de planta, reforestación y su mantenimiento, protección de taludes, etc. Se deben definir indicadores para conocer cómo se comportan los componentes principales como suelo, agua, fauna y dinámica espacio-temporal de la vegetación. En este caso se presenta la publicación “Protección y Conservación Ambiental, Autopistas: México –Tuxpan y México Pachuca”, la primera es en una zona completamente rural, mientras que la segunda se encuentra en zona urbana y se muestra la diferencia en problemática ambiental y

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soluciones para mitigar los impactos negativos causados y restaurar los sitios afectados por las actividades de construcción.

**Programa de manejo forestal para la microrregión Sur Oriental de San Antonio del Tequendama**

_Rivera Galvis, Luis Adrián_

*Universidad Distrital Fransisco José de Caldas*

La importancia del correcto manejo de los recursos forestales ha impulsado a que se realice este estudio en donde el conocimiento del estado de los sistemas forestales presentes en el área de la microrregión Sur Oriental de San Antonio del Tequendama, la zona sobre la cual se realizaron los estudios tienen una extensión de 2398 ha siendo un 29,8% del Municipio, este se encuentra ubicado en el Departamento de Cundinamarca-Colombia. La importancia en cuanto al manejo de los recursos forestales pero con el conociendo claro que da un estudio microrregional y de igual forma apoyados en los conocimientos de la ordenación de los bosques. La zona de notable valor ecológico debido a que existe una cobertura forestal importante principalmente representada por ecosistemas estratégicos y formaciones vegetales de bosque seco montano bajo y bosque húmedo montano bajo, las especies mas representativas de estos tipos de bosques que se encuentran presentes son: _Dodonea viscosa, Rubus sp, Solanum marginatum, Ephorbia arboiculata, Oreopanax sp, Tunus, Cordia, Ficus sp_, entre otros. Lo que se pudo evidenciar en este estudio es que la generación de procesos degradativos por procesos agrícolas entre los que se resalta el sembrado de la Ruda, el cual es un cultivo que es poco viables ecológicamente y económicamente, además de esto se evidencio la presencia de sistemas forestales en los que se utilizaban a los arboles de una de multipropósito (cecas, alimento humano, alimento animal y leña).

**Métodos de restauración ecológica de vegetaciones ribereñas después de la explotación de carbón en el sur de Brasil**

_Rocha Nicoleite, Edilane; G.T. Colombo, V. Citadini-Zanete, R. Martins, S.C. Muller_

*Universidade Federal do Rio Grande do Sul*

El término restauración se entiende como un proceso que auxilia a la recuperación de un ambiente alterado, en diferentes grados, con la finalidad de crear un ecosistema sustentable y resiliente, muy semejante al natural. Actividades de explotación mineral son altamente impactantes en el medio ambiente haciendo de la restauración un proceso de gran complejidad, pues, tanto la vegetación, como el suelo son removidos. En el estado de Santa Catarina, sur de Brasil, los pasivos ambientales resultantes de la explotación de carbón totalizan 6.500 ha, incluyendo áreas de preservación permanente, como las riberas de ríos denominadas vegetaciones ribereñas, que son sistemas de fundamental importancia ecológica y social debido a la protección de los recursos hídricos. Buscando la restauración efectiva principalmente de estos ambientes, fueron creadas reglamentaciones específicas para la región carbonífera que indican que estos ambientes deben ser reconstituidos posibilitando el retorno de las funciones forestales y ecológicas. Los principales métodos aplicados abarcan cinco recomendaciones: remoción de materiales contaminantes; adición de arcilla y materia orgánica; introducción de cobertura herbácea para protección del suelo; siembra de esquejes de especies forestales nativas; evaluación y control. Aun siendo estas etapas consideradas un patrón para proyectos de restauración, el caso del sur de Santa Catarina es peculiar, especialmente por la necesidad de reconstrucción del suelo en un grado que posibilite la evolución y sustentabilidad del nuevo sistema. Las respuestas obtenidas durante la investigación podrán contribuir para la restauración ecológica en Brasil, y en otros países que presenten problemas semejantes por actividades de explotación de carbón.

**Beneficios de la dasonomía urbana**

_Rodrigo López, José Trinidad; Diana Chorley Gallardo_

*Universidad Autónoma Chapingo*

La vegetación urbana es importante para los habitantes y fauna que habitan en las ciudades por muchas razones, hay especies que tienen importancia ecológica ya que brindan alimento y refugio a pequeños mamíferos y aves principalmente. La importancia de contar con espacios verdes en las ciudades brinda un aspecto estético asombroso, además de traer beneficios económicos, en la salud física y mental, regulan la temperatura creando microclimas, funcionan como barreras amortiguadoras de vientos fuertes y ruido. Existen especies que son utilizadas en plantaciones urbanas por la respuesta que están en ecología con graves problemas de contaminación del aire, de allí la importancia de contar con espacios verdes en las ciudades, ya que mejoran nuestra vida. En algunas ciudades es común ver especies exóticas y nativas que forman parte de estos bosques urbanos y que sin embargo
aportan beneficios a pesar de estar sometidas al maltrato o descuido, la contaminación y el olvido, no debamos permitir que estos espacios mueran o se sigan deteriorando, ya que son importantes.

**La importancia de estudio fitosociológicos para restaurar las áreas degradadas en los márgenes de ríos y reservorios**

Rodrigues Pereira de Noronha, Marilia; Cinthia Aparecida da Silva, Edson Junior Ferreira, Stefani Juarez dos Santos

Univ Estadual Paulista

Las florestas en los márgenes de ríos en el Brasil son extremadamente heterogéneas, exhibiendo una gran diversidad florística de acuerdo con la región geográfica, clima, altitud, tipo de suelo, entre otros, tomando necesarios estudios fitosociológicos en locales próximos a las áreas que se pretenda replantar. La restauración de esas florestas tiene que ser realizada con especies autóctonas y típicas de cada región. Con el objetivo de comparar la fitosociología, estructura y diversidad de dos fragmentos de la floresta semidecidua del noroeste del estado de São Paulo, siendo un localizado en Pereira Barreto (PB), al margen del Río São José dos Dourados (20°28'S 51°15'W, 370 ha) y otro en Castillo (CA), al margen del Río Tieté (20°37'S 51°33'W, 499 ha), fueron realizados levantamientos fitosociológicos utilizando el método de cuadrantes. Fueron mostrados más individuos (764) y especies (56 en PB que en CA (448 individuos y 38 especies), siendo el Índice de Shannon en la primera de 2.94 y de 2.38 en la segunda. Las diez especies con mayor índice de valor de importancia en PB también ocurren en CA, pero solo 24 (42,8%) del total son comunes a las dos áreas. Aunque 65% de las especies encontradas en CA también ocurren en PB, dos de las más importantes no fueron registradas en esta última.

**Viveros: Aporte al desarrollo sustentable y alivio de la pobreza**

Rodriguez Araujo, María Emilia; Daniel R. Pérez, Adriana E. Rovere, Florencia M. González

Universidad Nacional del Comahue

La provincia de Neuquén (Argentina) posee gran parte de territorio desertificado, lo que ocasiona baja productividad, reducidas oportunidades laborales y/o productivas, pobreza y carencias socioculturales. El objetivo de este trabajo es mostrar como la capacitación de los pobladores en relación a la temática de la restauración/rehabilitación, cambia las condiciones de pobreza y aporta al desarrollo sustentable del área. Para ello se realizó un acuerdo entre sectores privados (principalmente empresas hidrocarburíferas y/o mineras), organismos gubernamentales y no gubernamentales de las localidades de Añelo y Neuquén. Luego se realizaron encuestas y talleres a fin de conocer la percepción de los pobladores locales sobre el medioambiente y la problemática local. A partir de ello se planificó junto a los actores involucrados las etapas de trabajo: reconocimiento de plantas, desarrollo de viveros, técnicas para la reproducción de plantas y cálculos económicos de producción. Actualmente, luego de ocho meses de iniciado el proyecto, se ha finalizado la infraestructura de los dos viveros, y existe una disponibilidad de más de 10000 plantas nativas de *Atriplex lampa, Grindelia chiloensis, Larrea divaricata, Larrea nitida, Senecio filaginoides, Senecio subulatus* y *Pappostipa speciosa*, que ya se están comercializando y empleando en rehabilitación de áreas degradadas. Consideramos que propuestas de capacitación a pobladores rurales en áreas desertificadas, aportan a aliviar la pobreza y a más largo plazo un desarrollo sustentable.

**La disponibilidad de luz bajo el dosel mediante fotografías hemisféricas y sus implicaciones fitosociológicas en tres coberturas con diferente modo de restauración en Orosí, Cartago, Costa Rica**

Rodríguez Corrales, Adrián; Roberto Cordero

Universidad Nacional de Costa Rica

La disponibilidad de luz, la cual varía de acuerdo al estado de regeneración ecológica, influye directamente sobre las especies vegetales y animales que se encuentran bajo el dosel y determina en gran medida sus procesos fisiológicos, reproductivos, morfogéneticos y ecológicos. En este estudio se caracterizó la cantidad de luz disponible bajo el dosel utilizando fotografías hemisféricas en tres sitios con modos de restauración contrastantes: un bosque de referencia (B, 50 años), una finca abandonada (F, 15 años) y un cipresal (C, 35 años). Cada sitio se dividió en 50 subparcelas continuas (10x10 m) en cuyas esquinas se tomaron de 3 a 5 fotografías variando exposición y apertura del lente. Cada fotografía fue analizada con el programa Hemiview 2.1. El índice de área foliar (LAI) varió significativamente entre las parcelas (B>C>F). La proporción de claros (GSF) fue menor en el bosque (0.073), seguido del cipresal (0.114) y el tacotal (0.214). La radiación total en el sotobosque (TotBe) presentó la misma tendencia. El análisis de componentes principales encontró dos componentes que explicaron el 97% de la variación total. El primer componente está representado mayormente por el TotBe, y la radiación directa y difusa, y el segundo por el LAI y el área foliar promedio. Estos componentes fueron claramente separadas por sitio de acuerdo a un análisis de varianza.
El estado de desarrollo y la complejidad estructural de las coberturas estudiadas fueron reflejadas en la disponibilidad luminica y nos permite evaluar el éxito de estos modos de restauración.

**Estudio de la variabilidad genética de *Sechium edule* en cultivos de Jalisco y Michoacán con miras al mejoramiento de la especie**

Centro Universitario de la Ciénega/Universidad de Guadalajara

El chayote (*Sechium edule*) actualmente se encuentra en situación desfavorable debido a la gran incidencia de enfermedades, por lo que se propone conocer la similitud entre los individuos y las poblaciones ya que es de gran utilidad en los programas de mejoramiento genético, pues permite la organización del material y la selección adecuada de los genotipos, así como la complementación con datos fenotípicos y agronómicos para el desarrollo de una población mejorada. Con ello se implementara el inicio de las alternativas que se ofrecerán a los productores de chayote para la mejora de la especie.

**Experiencias en la determinación del carbono capturado por cinco especies arbóreas y arbustivas utilizadas en programas de restauración del bosque seco altoandino en la Cordillera Oriental, Colombia**

Rodríguez Santos, Nathaly; Omar Melo Cruz, Ferney Augusto Rojas, Alexander Ibagón Montes
Universidad del Tolima

El trabajo de investigación describe los resultados sobre el contenido de carbono presente cinco especies nativas del boque andino existentes en el Parque Ecológico “La Poma”. Las especies seleccionadas para el estudio fueron *Dodonaea viscosa*, *Abatia parviflora*, *Escallonia paniculata*, *Baccharis macrantha* y *Quercus humboldtii*. Se desarrollaron dos metodologías; la primera consistió en una metodología no destructiva, mediante la instalación de 66 trampas de recolección de necromasa de la hojarasca (36 en plantación y 30 en regeneración natural). Luego de seis semanas de recolección y análisis del material depositado en las trampas de cada sitio, se determinó de acuerdo al peso seco de la hojarasca el contenido de carbono. La especie que mayor contenido presento fue *Abatia parviflora* con 1.6 TmC/Ha/año, para un diseño de plantación a tres bolillos de nueve m2 y de 1.2 TmC/Ha/año, para un diseño de plantación a tres bolillos de doce m2 y la segunda metodología, de cosecha, consistió en la determinación del contenido de carbono por el método de Walkley y Black de los compartimentos funcionales (raíces, tocón, ramas, ramillas y hojas) de los cinco individuos por especie, clasificados en cinco categorías de edad (2 a 10 años), los resultados obtenidos con esta metodología señalaron que la especie *Dodonaea viscosa* presentó la mayor tasa de acumulación de carbono con 4.4 TmC/Ha/año en promedio de las cinco categorías de edad. Siendo estas las especies nativas que se están empleando en los procesos de Restauración Ecológica adelantados en el Parque Ecológico “La Poma”, se obtuvieron excelentes resultados en cuanto al aporte de biomasa y adaptación a las condiciones particulares de la zona.

**Regeneración natural del nogal (*Cordia alliodora* R. & P.) para la restauración en fragmentos del bosque seco tropical en el norte del departamento del Tolima, Colombia**

Rodríguez Santos, Nathaly; Omar Melo, Fernando Fernández
Universidad del Tolima

La investigación se realizó en fragmentos de vegetación, en el bosque seco tropical, del valle del río Magdalena, en el Departamento del Tolima. En un fragmento de 40ha, se realizó una evaluación ecológica basada en transectos temporales de 0,1ha. Realizándose mediciones sobre los individuos, con diámetro normal mayor e igual a 5,0cm. Como resultado se obtuvo que *Cordia alliodora* (R. & P.), presentó más del 50% de los individuos, distribuidos en todo el perfil y generando patrones gregarios dentro del bosque. En una segunda fase, se estableció una red de 45 parcelas permanentes de 25m2, para monitorear la dinámica de la regeneración natural de dicha especie, la cual fue evaluada, inventariada al 100% y caracterizado su hábitat. Obteniendo preliminarmente que la tasa de reclutamiento es un 60% mayor que la mortalidad, lo cual permite que las nuevas cohortes de *C. alliodora* se establezcan exitosamente en los fragmentos. Los requerimientos básicos de tipo ambiental son alrededor del 40% de intensidad luminica, un 55% de cobertura de dosel y contenidos de humedad del suelo entre 20 y 30%. Finalmente, en todo el fragmento se realizaron actividades silviculturales de liberación, raleo y control de lianas, para los individuos de *C. alliodora*, a los cuales se les monitoreo su crecimiento. Se determinó que la tasa media de crecimiento dimétrico, supera los 1,8cm/año; clasificándose como de rápido crecimiento. Se concluye que estrategias de manejo
silvicultural, permitirán reincorporar áreas degradadas de bosque seco tropical a la economía forestal de la región y bienestar para los habitantes.

**Diversidad florística y estructura vegetal para definir un modelo de restauración ecológica en áreas de bosque seco alto andino de la Cordillera Oriental, Colombia**

Rodríguez Santos, Nathaly; Omar Melo Cruz, Ferney Augusto Rojas  
Universidad del Tolima

Se propuso implementar un modelo de restauración ecológica basado en la diversidad florística y la estructura de las comunidades vegetales del Parque Ecológico La Poma, ubicado en la cordillera oriental colombiana, con temperatura media de 8°C, presencia de heladas todo el año, asnm entre 2.500 y 2.700 metros, precipitación media anual de 600 mm y se clasifica como bosque seco Montano Bajo (bs-MB). Se establecieron tres parcelas permanentes de 1,0 hectárea en tres tipos de cobertura. Se evaluó la diversidad florística a nivel alfa (riqueza de especies, dominancia y heterogeneidad). Igualmente, se determinaron parámetros estructurales de la comunidad (importancia ecológica de las especies tanto arbóreas como arbustivas, la proporción de mezcla y los patrones espaciales de distribución dentro de la comunidad. Según lo anterior se establecieron arreglos de plantación en campo, sobre áreas cuyo uso pasado del suelo fue la ganadería extensiva y los cultivos de papa. Se utilizaron 32 especies de árboles y arbustos. Las especies con mayor respuesta en crecimiento fueron *Dodonaea viscosa*, *Escallonía paniculata*, *Quercus humboldtii*, *Cedrela montana* y *Baccharis macrantha*. Las especies más afectadas por las heladas fueron *Quercus humboldtii* y *Oreopanax floribundum*. Las especies utilizadas como fuente de alimento por folívoros y frugívoros fueron *Cavendishia cordifolia*, *Myrcianthes leucoxyla* y *Alnus acuminata*. Los arreglos implementados presentaron una similaridad cerca del 65% frente a las comunidades evaluadas y la estructura presentó mezclas equivalentes a la de la vegetación natural del Parque, lo que permitió recuperar estas áreas simulando tanto la forma como la función de la vegetación natural.

**Testing the performance of 14 native tropical tree species in two abandoned pastures of the Lacandon Rainforest Region of Chiapas, Mexico**

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El Colegio de la Frontera Sur

The rainforest of Mexico has been degraded and severely fragmented, and urgently requires restoration. However, the practice of restoration has been limited by the lack of species-specific data on survival and growth responses to local environmental variation. This study explores the differential performance of 14 wet tropical early-, mid- or late-successional tree species that were grown in two abandoned pastures with contrasting land use histories. After 18 months, seedling survival and growth of at least 7 of the 14 tree species studied were significantly higher in the site with a much longer history of land use (Site 2). Differences in performance among early-successional species were noted in relation to the differential soil properties between the experimental sites. Mid-successional species generally showed slow growth rates but high seedling survival, while late-successional species exhibited poor seedling survival at both study sites. Stepwise linear regressions revealed that the species integrated response index (IRI) combining survivorship and growth measurements, was influenced mostly by differences in soil pH between the two abandoned pastures. Our results suggest that local environmental variation among abandoned pastures of contrasting land use histories influences sapling survival and growth. Furthermore, the similarity of responses among species with the same successional status allowed us to make some preliminary site and species-specific silvicultural recommendations. Future field experiments should extend the number of species and the range of environmental conditions to identify site “generalists” or more narrowly adapted species, that we would call “sensitive”.

**Reducing disturbance of rape cultures agro ecosystem by management of phytosanitary treatments taking into consideration agro – ecological conditions**

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Based on legislative framework that governs the agriculture activity it is presented new concept of Plant Protection Products Regulation and possible impacts on agricultural practice in Romania regarding using of pesticides. A significant number of pesticides were replaced by new ones with a result of quantitative changes of pesticides used and application frequencies, especially in rape culture in order to protect pollinators. For example, in present there are few insecticides for pest control in rape and in the next years more than a half of them will lose their license.
Current and future techniques that can be utilized for insect pest management in oilseed rape (OSR) crops depend on EU regulations and of course Romania has to follow these rules. The economic constraints on OSR production is in function with the potential of technology for insect pest management. Successful integrated pest management (IPM) in OSR will depend on the use of expert systems to put together disparate aspects of pest control into an IPM programme that will be appropriate with particular pest problems from Romania. Our objective was to establish the structure of main pests of canola crops in south-eastern Romania, the structure and biology of pests’ population in rape agroecosystem, their connection with ecological factors especially the weather. Economically speaking, from the total collected entomofauna, the most important species, due to both registered densities and attacks in rape, are few species in the same time in particular years or places other pest can cause problems in rape culture.

Restauración del capital natural: Desarrollo de un índice etnoecológico de restauración

**Rovere, Adriana Edit; Soledad Molares**
Universidad Nacional del Comahue

Adicionalmente a la recuperación del área degradada, por medio de la restauración ecológica, se recuperean otros aspectos importantes relacionados al capital natural (bienes y servicios). Analizamos el uso etnobotánico de las especies vegetales presentes en un área degradada dentro de la reserva nacional Lago Puelo (Argentina), que se halla sujeta a un plan de restauración ecológica. Para cada especie se realizó una búsqueda bibliográfica de sus usos, utilizando fuentes originales de trabajos realizados en la región. Las categorías de uso analizadas fueron: medicinal y simbólico, comestible, forrajeador, tintóreo, artesanal, forestal (leñatero y maderable), ornamental y otros usos. Con esta información se calculó el valor de uso total de cada especie. También para cada especie se estableció un valor ecológico de restauración, que consideró el origen biogeográfico de las especies y su hábito de crecimiento. Teniendo en cuenta ambos valores, se diseñó un índice de restauración etnoecológica, el cual relaciona la importancia cultural con la ecológica de cada especie. Se aspira a que la utilización de este nuevo índice etnoecológico contribuya a la implementación exitosa de una estrategia de uso sustentable de los recursos locales, integrando de manera armónica la sociedad con el ambiente, a fin de promover el bienestar humano y la conservación de los ecosistemas a largo plazo.

Restauración pasiva: Evaluación de la dispersión de semillas

**Rovere, Adriana Edit**
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Analizamos la dispersión natural de semillas de especies leñosas en un área de restauración en el Parque Nacional Lago Puelo (Argentina) a fin de evaluar una parte de los mecanismos que conduce a la restauración pasiva del sitio. Para ello se colocaron en marzo de 2010, 40 trampas de malla plástica de 0,25 m² en cada uno de los ambientes presentes: el área de referencia que es un bosque maduro de *Nothofagus dombeyi*, áreas de bosques secundarios de *Austrocedrus chilensis* y en un el sector más alterado que corresponde a un matorral fuertemente invadido por especies exóticas. A fines del otoño, finalizada la mayor dispersión de las semillas, se recolectó el material y las muestras se separaron en laboratorio. Las semillas fueron identificadas y contadas. En promedio la dispersión de semillas fue mayor en el área de bosque primario (2300 semillas/m²), intermedia en el bosque secundario (114 semillas/m²) y menor en el área de matorral (40 semillas/m²). En cada uno de los ambientes se encontraron tanto semillas de especies nativas como exóticas, dispersada por aves y por otros mecanismos. Se resalta la necesidad de controlar las especies exóticas presentes y de incluir especies nativas con frutos carnosos, para aumentar la dispersión por medio de las aves.

Programa de restauración ecológica proyecto minero “San José”, San José del Progreso, Ocotlán

**Ruiz Vega, Jaime; I. Piña-Espallargas, M. Caleb-López**
CIIDIR OAXACA, IPN

En marzo de 2009 la empresa Minera Cuzcatlán S. A. de C. V. presentó ante la Delegación de SEMARNAT en el Estado de Oaxaca una Manifestación de Impacto Ambiental, Modalidad Particular, denominada “Proyecto San José”, donde se incluyó la construcción de la infraestructura correspondiente a la Planta de Beneficio y Presas de Jales, misma que fue autorizada de manera condicionada a elaborar un Programa de Restauración Ecológica (PRE). En el PRE, elaborado por personal del CIIDIR OAX, IPN, se recomienda dejar una pendiente del 4-5 % en el relleno de la presa de jales SO, con lo cual, además de disminuir el impacto paisajístico, se pueden construir bordos al contorno y atenuar el riesgo de erosión. Se debe promover la formación de corredores biológicos para que la fauna pueda moverse de los refugios hacia los sitios con mayor disponibilidad de agua y alimento. A fin de proporcionar agua
potable para la fauna y ganado, se debe mantener llena la poza principal, ubicada aguas debajo de la presa de jales SO. Finalmente, se propone la creación de un fondo para promover la restauración de tierras degradadas en las proximidades del proyecto San José. Algunos temas para investigación a futuro serían: uso del análisis geomorfológico como una herramienta para la caracterización estructural de los geocosistemas y el diseño y validación de indicadores de desempeño de la restauración ecológica.

**Effects of management and stand age on species richness of bird communities in post-mining areas: A conservation perspective**

**Salek, Miroslav; Marketa Hendrychova, Michal Rehor**  
Czech University of Life Sciences

Coal mining is accompanied with an extensive superimposing of extracted materials and results in negative landscape alterations that are mitigated using reclamation programs. A modern alternative to conventional reclamation practice promoted in favor of biodiversity, natural plant succession, is scarcely implemented in Europe. Impacts of these management alternatives on animal communities remain unstudied, particularly with respect to age of restored stands. We examined the effects of management type (agricultural reclamation, afforestation, spontaneous succession) and stand age (3 to 45 years from initiation) on bird communities in post-mining areas in Northern Bohemia, Czech Republic, central Europe. We found that the lowest species richness of birds was attributable to early stands (3-7 years) with a strong difference in conservation value between spontaneous successions inhabited by rare rural species and reclaimed sites dominated by common farmland species. Species richness increased with stand age but remained lower on reclamation than on successions. The proportion of scarce species declined with increasing stand age. On afforested stands (20-45 years), species richness was significantly lower in uniform tree plantations compared with diverse mosaics of tree clumps interspersed with small open patches. Exotic shrubs were avoided by breeding birds. We concluded that a support for early successional stands combined with diverse non-uniform plantations of autochthonous wood species positively contribute to bird richness in post-mining areas and maintain their conservation value.

**Valoración del paisaje como una herramienta de análisis del aprovechamiento local de recursos forestales en áreas naturales protegidas: Buenavista, una comunidad del Parque Nacional Nevado de Toluca**

**Salgado Hernández, Mario del Carmen; Tizbe Teresa Arteaga-Reyes, Arturo Balderas-Torres, Sergio Franco-Maass**  
Universidad Autónoma del Estado de México

La degradación de bosques del Parque Nacional Nevado de Toluca, sugiere la existencia de un uso inapropiado del territorio por parte de las comunidades asentadas al interior del área natural protegida. En este énfasis, surge el interés por el valor del paisaje como una alternativa de análisis ambiental a escala local; se aplica una metodología que involucra la caracterización ecológica-estructural de la zona de estudio y las perspectivas de la población sobre la configuración del paisaje y el aprovechamiento sobre los recursos forestales. Se desarrollaron indicadores de calidad y fragilidad visuales que requirieron de recorridos en campo, el empleo de Sistemas de Información Geográfica para la zonificación de áreas de mayor susceptibilidad ambiental y la aplicación de entrevistas a los habitantes. Los sistemas de paisaje identificados en la investigación son: montañas, pie de monte, planicie ondulada y valle, que son clasificados en 28 subsistemas a partir de ocupaciones de suelo e impactos antrópicos. De acuerdo a los valores de paisaje, se obtuvo que las áreas de montaña con pendiente superior a 35°, inaccesibles y con presencia de bosque de oyamel son de menor fragilidad. En contraparte, las superficies de pie de monte y planicie ondulada son más accesibles a la población y por lo tanto, registraron fragmentación en el paisaje natural, principalmente por la explotación de recursos forestales, la agricultura y el pastoreo. En este contexto, el valor del paisaje representa una alternativa invaluable en la generación de información que contribuye a las estrategias de restauración de ecosistemas de bosque.

**Rock around the flock: Determining the influence of quarry exploitation on the distribution of bird communities at SECIL-CMP cement plant, Portugal**

**Salgueiro, Pedro; C. Silva, A. Silva, C. Só, A. Mira**  
Universidade de Évora

Quarries are known to have deep impacts over habitats and faunal communities, such as disturbance, vegetation removal, refuge scarcity and depletion of food resources. This study aims to determine which landscape attributes
assume significant roles in shaping local animal populations near active quarries, using birds as a case-study. The study was carried out in two SECIL cement plants located in Maceira and Pataias. Both areas are landscape mosaics of pine forests intermixed with agricultural plots, scrublands and urban areas. We access the composition and distribution of bird communities in 40 sampling point counts located in the vicinity of the quarries. Multivariate statistical analysis and interpolation techniques were applied in order to evaluate bird diversity and richness and determine the main attributes influencing bird communities. Our results show that a higher species richness and diversity occurs at higher distances from the quarries. Nevertheless, most significant attributes explaining species occurrences are related with vegetation coverage. The analysis allowed us to determine the most valuable areas and site characteristics that more significantly benefit bird communities. Results will help decisions concerning quarry restoration. In order to promote bird colonization in future recovered areas we suggest an active management of the vegetation promoting mostly a mosaic of dense forested areas and shrub patches. The most valuable areas should be maintained, once they seem to be population sources. Connectivity between recovered and natural areas should be promoted in order to allow a more efficient dispersal of birds.

**Distribución espacio-temporal de los incendios forestales en Durango, México**

Salmerón Macías, Marisela
CIDIR-IPN Durango

Los incendios forestales son un factor importante en la disminución de áreas boscosas, en dichas áreas se afecta la provisión de bienes y servicios ambientales. En este estudio, se analizó la ocurrencia de los incendios forestales respecto a la distancia de caminos y localidades. Se estima la distribución espacio-temporal de los incendios ocurridos en la parte occidental del estado utilizando los registros de incendios de la CONAFOR. Se emplearon Sistemas de Información Geográfica para estimar la distancia entre los incendios y las vías de acceso y localidades. Se calculó un Índice de Gravedad Poblacional considerando el número de habitantes en un radio de 20 km respecto a cada incendio. Los patrones de distribución espacial se calcularon con el método de cuadrantes considerando el coeficiente de varianza y la prueba de Kolmogorov Smirnov. Los resultados indican que los incendios con menor superficie se encuentran más cerca de los caminos y los alejados tienen mayor superficie afectada. Sin embargo, la ocurrencia de los incendios con respecto a la cercanía a localidades no parece tener relación. El Índice de Gravedad Poblacional permitió confirmar que no existe relación entre el número de habitantes e incendios. Por último, se encontró que los incendios presentan una distribución de forma agregada, lo que sugiere que la concentración de dichos eventos se da en su mayoría cerca de los caminos, en el cuál, la incidencia del hombre es mayor.

**Similarity of vertebrate species between two sites under 5 years of restoration in central Mexico**

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Universidad Nacional Autónoma de México

Ecological restoration projects must perform monitoring of the biotic components to adjust the subsequent actions. In this study, we monitored the vertebrate species in two sites under restoration (A8 and A11) and one reference zone (RZ) in the reserve “Reserva Ecológica del Pedregal de San Ángel, D.F.” (Mexico). We found 91 native species (1 amphibian, 4 reptiles, 78 birds and 8 mammals). The three sites have similar species richness and diversity. Similarity index values for native communities were higher between A8 and RZ (ISJ = 69.9%, ISS = 82.3%), which can be explained by the vertical structure of vegetation at both sites. The bird species with higher frequency were the bushtit (Psaltriparus minimus) in A8; the Mexican sparrow (Carpodacus mexicanus) in A11 and the yellow-rumped warbler (Dendroica coronata) in RZ. The more abundant small mammal in A11 and RZ was the mouse (Peromyscus gratus), while in A8 it was the exotic mouse (Mus musculus). The southern rock deer mouse (Peromyscus difficilis), the opossum (Didelphis virginiana), the rat (Rattus norvegicus) and the domestic cat (Felis catus) were only recorded in A8 and A11. The western spotted skunk (Spilogale gracilis) was exclusively recorded in RZ. The similarity between sites could be explained by the process of ecological restoration. However, the presence of exotic species in the sites under restoration suggests the necessity of continuing restoration actions in order to recover even more ecosystem functionality.

**Restauración ecológica en la reserva ecológica del Yumka, Tabasco, México**

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La regeneración natural se está perdiendo en las Reserva Ecológica Yumka emplazado por el cambio de uso del suelo lo que ha provocado que exista pérdida de la cobertura vegetal esto a su vez ha repercutido en la erosión y conservación de suelo. Esta investigación está evaluando la regeneración natural de la vegetación y su efecto en la restauración y conservación del suelo la Reserva Ecológica del Yumka. Se establecieron 20 cuadros permanentes de 1 x 1 m distribuidos al azar en el área para evaluar la regeneración. Además se realizaron recorridos en el área para establecer sitios de recuperación y conservación de suelos. Del primer censo efectuado en el área se obtuvo que el luín (Ampelocera hottei) fue la especie que presenta la mayor abundancia de individuos juveniles seguida por la palma coyol real (Attalea butyracea). En cambio de el ramón (Brosimum morrisiana) presente en un 90% la abundancia de arboles adultos y el 10% corresponde a individuos de la categoría juvenil. Lo que nos está indicando que esta especie no se está regenerando en el Reserva. Por lo que se propone para restaurar este ecosistema primero establecer terrazas en las zonas con mayor erosión del suelo y conservar la hojarasca (ramas, hojas, flores y frutos) se incorporen al suelo. Se propone establecer almacigos dentro de este ambiente en el que se recluten nuevos árboles de la selva como el ramón en los suelos luvisol cutani-férreos

Restauración ecológica y arborización urbana: Esfuerzos por mejorar la vida en la ciudad
Santacruz García, Noé; A. Espejel Rodríguez, D. Cruz de la Serna
El Colegio de Taxcoala

La reforestación urbana tradicionalmente ha seguido dos vertientes, por un lado, la conservación y/o restauración de áreas que mantienen su cubierta vegetal original, y por otro la introducción de árboles en espacios abiertos de uso público, sitios donde se tiene la oportunidad de unificar el uso estético de la vegetación y su potencial para mejorar la habitabilidad de las ciudades. Así, tomando como pregunta guía ¿cuál es el mejor árbol para las ciudades? se revisan los conceptos de restauración, reforestación y arborización aplicados al ambiente urbano. Se analizan ventajas y desventajas del uso de especies tanto nativas como introducidas, empleadas en reforestación y arborización urbana, considerando especialmente los cambios provocados en el ambiente (en temperatura, humedad, luminosidad, velocidad del viento) por el proceso de urbanización y los aspectos socioculturales (uso del espacio, preferencias), que pueden dar lugar a condiciones adversas tanto para las especies nativas, teóricamente mejor adaptadas al sitio, como para exóticas, cuyo empleo puede resultar en una inversión infructuosa pues beneficios esperados de su uso no serán alcanzados. O por el contrario, creación de condiciones muy favorables que propicien la propagación de especies potencialmente invasoras que pueden desplazar a la vegetación nativa. A modo de conclusión se plantea entonces que el mejor árbol para arborización urbana es aquel que enfrenta mejor las condiciones de la ciudad y produce los mayores beneficios.

Enrichment planting with Campomanesia phaea in secondary Atlantic Rain Forest fragments
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Universidade Estadual Paulista

Enrichment planting with Campomanesia phaea in secondary Atlantic Rain Forest fragments Cambuci (Campomanesia phaea) is an endemic Atlantic Forest species, bearing fruits that are known an important non timber forest product for comfitures, spirits and in natura consumption. However, due to deforestation and habitat degradation this species has become increasingly endangered. We assessed cambuci’s development in an enrichment planting system in secondary forest fragments inside Sao Paulo City Green Belt Biosphere Reserve, at Embu das Artes County, located at Morro Grande Reserve surroundings. In spite the study area belongs to species’ natural distribution range, it’s no longer found over there. Five seedlings per plot were planted in four blocks of each of two fragments with different successional stages: low height secondary forest (LHSF) and medium height secondary forest (MHSF). Seedlings survivorship and growth were periodically assessed and data were compared using survivorship and growth analysis. We found no significant differences between sites for survivorship and growth, indicating that both sites were adequate for enrichment plantings with this species. Survivorship was low (58.3%) in both fragments, but mortality rates were concentrated during the early phase after planting. We recommend that enrichment planting density should be at least the double of final desired population density. Further ecological studies are necessary to improve enrichment techniques for this species.

Recovery field study on quartzity rock
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Federal University of Ouro Preto
Rupestrían fields of Conceição do Mato Dentro MG, Brazil are a sensitive and threatened ecosystem due to mining activities. This study investigated the introduction of native species and seedling survivorship in restoration projects in this impacted area. A randomized block design was performed, with each block having three plots of 2 x 2 m divided into Control, Managed where invasive species were removed, and planting - where native species were reintroduced. This sample design was conducted in two distinct areas, one in a rocky outcrop and the other in the grasslands. Five blocks were arranged in three transects for each area, totaling 15 transects. The plots were chosen for planting a total of eight native species and the number of individuals was doubled, totaling 330 plants reintroduced. The seedling survival rate was lower in the rocky outcrop than in the grasslands. Geomorphology and soil accumulation are among the conditions that favor survival in a structured rock outcrop in comparison with open, sandy grassland.

**Spontaneous succession vs. technical reclamation in disused sand pits**

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Different stages, either spontaneously re-vegetated or technically reclaimed, were analyzed in a higher number of sand pits located in a Protected Landscape Area in the Czech Republic, central Europe. Vegetation was sampled using phytosociological relevés. The preliminary results indicate that sites left to spontaneous succession exhibited higher species diversity than those that were technically reclaimed and the difference increased in time. The local species pool played a role. Technical reclamation did not accelerate succession towards target vegetation. Alien species decreased in their importance during succession, including newly invading species Agrostis scabra. Using spontaneous succession appeared to be better and cheaper way to restore vegetation in the disused sand pits. Diverse semi-natural vegetation developed which is especially important in the Protected Landscape Area.

**Strategies for post-wildfire re-establishment of Wyoming big sagebrush communities in the Great Basin, USA**

Shaw, Nancy; Robert Cox, Mike Pellant, Ann L. Hild, Megan Taylor
USDA Forest Service

The cycle of wildfire and annual weed invasion has degraded vast areas of Wyoming big sagebrush (Artemisia tridentata ssp. wyomingensis) in the western United States, disrupting ecosystem functioning, altering fire regimes, and reducing biodiversity. Successful revegetation of these communities is difficult. We examined approaches for re-establishing Wyoming big sagebrush and associated understory species following a 2008 wildfire in northeastern Utah. Treatments tested two drills, the standard rangeland drill and a minimum-till drill on 0.2 ha plots. Large seeded species, primarily grasses, were seeded in alternate rows. Small seeded species, including sagebrush, were broadcast seeded through the drill in intervening rows and covered (drill broadcast) or hand broadcast to simulate aerial seeding. Treatments were a control and six treatments for each drill: fall drill, no seed (to simulate seeding failure); fall drill grasses and drill broadcast small seeded species with sagebrush at a standard, 5X or 10X rate; and fall drill grasses with hand broadcasting of small seeded species (5X sagebrush rate) in fall or over snow in winter. With good precipitation in 2009 and 2010, grasses established successfully with all drill seeding treatments and reduced biomass of the exotic annual halogeton (Haloxylon glomeratus) by about 80% in 2010. Small seeded forb establishment was increased when seeded with the minimum-till drill. Sagebrush establishment was improved only with the 10X seeding rate. Establishment of Wyoming big sagebrush communities remains problematic due to low and erratic precipitation; but improved seeding equipment and strategies reduce the risk.

**The effect of mother soil and receiving site in boosting succession of karst degraded forest land in SW China**

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Chinese Academy of Sciences

Seeding (direct seeding or via soil seed bank replacing) is very common for boosting succession in degraded forest areas. However, different degradation stage (from forest to grassland) may have different responses to added seeds/soil seed bank. Primary forest (PF), secondary young forest (SF), shrub-land (SL) and grassland (GL) in formal karst forest area, SW China were selected and treated as a degradation series. 1m *1m *10 cm depth top soil of GL was replaced by that of PF, SF and SL, and SL by PF and SF, and SF by PF with 10 replications each in spring 2009. Seed emergence was observed and seedling survival was monitored monthly up to the end of 2010. The number of seeds germinated and number of species germinated was followed a linear and quadratic increase trends in 2009, and
the effect of time, the interaction of time and receiving site was significant. The same mother soil germinated more seeds at receiving site SL, and more seeds germinated from mother soil of SF at the same site. The survival rate of those germinated seeds followed a linear and quadric dropping trend through year 2010. The interaction of time and receiving site, interaction of time and mother soil were significant. The survival rate was higher at receiving site SL for the same mother soil, and was higher from mother soil of SF at the same site. Taking mother soil from mature forest is not the best choice for degraded ecosystems.

Situation de la invasión biológica del árbol de Jack, *Artocarpus heterophyllus*, en la reserva biológica de Dos Bocas, Espírito Santo, Brasil

Silva Crepaldi, Maria Otávia; Henrique Moreira de Melo Silva, Amanda Nogueira de Oliveira, Schirley Aparecida Costalonga

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Las especies invasoras, como segunda mayor causa de pérdida de biodiversidad del planeta, afectan el equilibrio de los ecosistemas naturales. La Reserva Biológica de Dos Bocas, con 2.910 hectáreas, posee aproximadamente 20 hectáreas invadidos por *Artocarpus heterophyllus*, planta exótica conocida como árbol de jack y que amenaza los recursos naturales por sus elevadas capacidades de crecimiento y reproducción. Ese trabajo analizó la estructura poblacional de *A. heterophyllus* en la Reserva Biológica de Dos Bocas, evaluando su densidad y dominancia, con el objetivo de analizar su potencial de invasión e embarazar los modelos de manejo y controles de especies invasoras. Fueron alocados diez transeptos con diez metros de anchura y cien metros de extensión cada, divididos en diez parcelas con 10 x 10m, con un total de 10.000 m² de muestreo; fueron mensurados altura y perímetro y calculados densidad relativa, frecuencia absoluta y relativa, dominancia absoluta y relativa, valor de cobertura e importancia. De 1.362 individuos, 720 (53%) eran especímen nativos y 642 (47%) eran *A. heterophyllus*, que presentó más individuos jóvenes que adultos (estándar “J” inverso), allá de valores de dominancia absoluta y relativa (58%), valor de cobertura y de importancia superiores al de especies nativas presentes en el muestreo, demostrando su carácter invasor, pudiendo llevar a pierda de especies botánicas nativas y consecuente homogeneización de la biota; por ser una unidad de conservación de protección integral, es recomendada su completa eliminación.

Proyecto de restauración ecosistémica de las dunas del Parque Estadual de Itaúnas, Espírito Santo, Brasil

Silva Crepaldi, Maria Otávia

Instituto Estadual de Medio Ambiente Y Recursos Hídricos del Espírito Santo

El Parque Estadual de Itaúnas, con 3.150 hectáreas, posee 21,70 hectáreas de dunas, cuya deforestación está afectando la dinámica de movilización de la arena e impactando el ecosistema. El objetivo de este trabajo fue implantar un proyecto para revegetación de 1,5 hectáreas de dunas. El alambrado de ventana basculante, para reducir la acción del viento y movilización de la arena, tuvo base de tetraedro hecho con seis piezas de eucalipto, teniendo 15m de una base a otra y con tres líneas paralelas de alambre distantes una de la otra por 0,60m, donde fueron fijadas pajas de *Attelea humilis* entrelazadas y paralelas al alambre. Fueron utilizadas especies heliofitas y pioneras, como *Dalbergia ecastaphyllum*, *Sophora tomentosa*, *Schinus terebinthifolius*, *Ipomoea pes-caprae*, *Abarema barnebyana* e *Canavalia rosea*, espaciadas 1 m entre sí; la abonación se dio por las hojas con biofertilizante SUPERMAGRO diluido a 2%, uno día antes de la siembra. En el interior de cada cueva fue puesto mitad de un coco para mantener la humedad y materia orgánica, así como fosfato y polímero de acrilamida. Entre las líneas de las siembras fueron sembrados Vetiver objetivando fijar la arena y proteger los tallos del viento; cuando los tallos estuvieron bien establecidos, la hierba será retirada. Los resultados preliminares indicaron 75% de supervivencia, siendo las más vigorosas *Anacardium occidentale*, *Canavalia rosea*, *Dalbergia ecastaphyllum* e *Sophora tomentosa*.

Does a Lord Howe Island palm vary across its altitude distribution? And what are the implications for future persistence? Ecological, genetic and demographic analysis of *Hedyscepe canterburyana*

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Sensitivity to climate change is believed to be a particular issue for species endemic to mountains on oceanic islands, due to limited migration possibilities and specialised ecology. A significant proportion of island endemics are already at threat. Threatened palm, *Hedyscepe canterburyana* is endemic to Lord Howe Island, restricted to high altitudes on
two mountains into cloud forest; invasive rat predation reduces seedling recruitment. This study investigated the distribution of genetic variation, morphology, growth characteristics, reproductive output and demographic structure of *H. canterburyana* across an altitude gradient. Demographic surveys determined population structure, reproductive values and development rates; then programmed into stage specific population models to investigate population growth rate at different altitudes. Rat predation impacts on population growth were also examined. Climatic records for Lord Howe Island were examined for climate changes in the last 70 years and if a subsequent range contraction of *H. canterburyana* has occurred. Microsatellite markers were used to compile the current genetic profile of the species. Significant and unexpected differences in development rate, population structure, reproductive output and population growth rate were identified between altitudes. Despite climatic changes being recorded, there is no evidence of a range contraction. Genetic variation and diversity was moderate and historical gene flow was high, indicating potential adaptive capacity distributed throughout the species range. However, there were low levels of recruitment resulting in significant declines in population size predicted in models. Modelled removal of rat predation reduced this decline, thus rat predation may be the greatest future threat to *H. canterburyana*.

**Promoting ecological restoration within the Midwestern United States**

**Smiley Jr., Peter; Jennifer Lyndall, Hua Chen**

USDA-Agricultural Research Service

Midwestern United States includes the north-central states ranging from the eastern border of Ohio to the western border of Iowa and encompasses a diverse range of ecosystems, such as the Great Lakes, wetlands, rivers, prairies, and forests. This diverse geographic region has been impacted by agriculture, industry, urbanization, and invasive species. As result there are a wide range of challenges facing ecological restoration projects. The promotion of ecological restoration is critical for facilitating coordination and supporting grassroots efforts in restoring degraded aquatic and terrestrial ecosystems within this region. The Society for Ecological Restoration (SER) recognized the Midwest-Great Lakes (MWGL) SER chapter as a regional chapter in March 2008. This SER chapter was formed to serve a six state region consisting of Ohio, Indiana, Michigan, Illinois, Wisconsin, and Minnesota. The chapter’s primary mission is to promote the science and practice of ecological restoration to assist with the recovery and management of degraded ecosystems within this region. Our objective is to summarize the MWGL SER Chapter’s activities in the past three years and report on what we feel were the most effective approaches for promoting ecological restoration. In the past three years we have established a chapter webpage, moderated an electronic listserv, developed a Facebook page, regularly published chapter newsletters, and held annual chapter meetings. Our experiences suggest that a combination of face-to-face and indirect electronic activities will be most effective in promoting ecological restoration to interested individuals and organizations.

**Restoration of forests, grasslands and arid lands, monitoring, management and technical aspects of restoration**

**Sobanski, Natacha**

Universidade Federal do Paraná, Brazil

Direct seeding is the second most used method for restoration of degraded areas. However, information about its efficiency, or at which stage of succession this technique displays better results are scarce. To evaluate the degree of success of this technique in different ecosystems, we performed an exhaustive search on published literature using direct seeding, restoration and tree species as keywords. We examined 120 publications (articles and theses). For this analysis, we collected information about the ecosystem (temperate and tropical), number of species used, germination rate, survival rate and the main cause of failure. Over 80% of the papers reported a very low average germination rate, usually below 50%. Seedling survival rates indicated still less satisfactory results, most ranging between 0 and 30%. About species tested, generally less than 20% were suitable for restoration due to their high germination rates. Besides that, site conditions such as weed competition, drought, and seed predation, strongly contributed to the failure of the technique. Therefore, based on available reported results, we infer that direct seeding is not an entirely appropriate technique for restoring ecosystems. The lack of survival data in most articles also reflects the need for further studies that provide restoration monitoring for longer periods, since the germination phase is not necessarily related to the success of all the restoration process.
**The effect of habitat fragmentation in the richness of extrafloral nectaries bearing plants in Brazilian Atlantic forest**

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Habitat loss and fragmentation have turned into the most important threats to biodiversity worldwide, but their effect on ecological interaction is still poorly known. Extrafloral nectaries (EFNs) are specialized nectar-secreting glands evolved to attract ants that protect plants against herbivores. Here we investigate the effects of forest fragmentation on the richness of EFN-bearing plants in a severely fragmented 670-km2 forest landscape of the Atlantic forest of north-eastern Brazil. We identified all EFN-bearing plants occurring in 40 0.1-ha parcels at three habitats: small forest fragments, forest interior and forest edge. A total of 260 individuals from 12 EFN-bearing plant species were found. Forest interior was significantly the most speciose habitat with 11 species, followed by fragments (8 spp.) and edge habitats (4 spp.). In addition, the three most common EFN-bearing plants species (Inga edulis accounting for 21.6% of all sampled plants, Protium heptaphyllum with 21.2%, and Simarouba amara with 20.8%) responded differently to habitat fragmentation. Inga edulis plants were found exclusively at the forest interior (94.2%) and small forest fragments (5.8%), while P. heptaphyllum were found at the forest interior (66.7%), small forest fragments (31.4%) and forest edge (1.9%). Finally, S. amara were recorded with similar percentage (~32%) at all habitats. Our findings indicate that forest edges and small fragments present a reduction in plants with biological defense against natural enemies, which may favor different types of herbivores in these fragmentation-affected habitats.

**Intersections of community, traditional knowledge, and place: A park design for the La Jolla band of Luiseño Indians**

Stout, Nathan
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For thousands of years, the Luiseño people have utilized the Southern California landscape to support their way of life. Their identity is a product of their relationship with this land and is reflected in their culture and traditional practices. Today for the Luiseño people, this relationship between land and culture is dissolving. This is especially true for the La Jolla Band of the Luiseño Indians. Recent shifts in both landscape and lifestyle threaten the persistence of La Jolla Band’s unique knowledge, traditional practices, and native language. The central challenge for this thesis is to examine ways in which the landscape can be designed to convey La Jolla cultural practices and provide a means for transmitting traditional knowledge. I have engaged with La Jolla tribal members, the La Jolla Environmental Protection Office, the San Diego Zoo Institute for Conservation Research, and University of Illinois faculty and peers to design a park for the La Jolla community that provides considerably more than the typical recreation activities we so often associate with a park. To guide my design process, I synthesized the criteria for success identified by each of the project partners and determined that to be successful the landscape must honor the past, acknowledge the present, and accommodate the future. Using a participatory process, I was able to provide design recommendations for an engaging and educational park landscape that integrates cultural gardens, community gardens, and recreational space into a contemporary context.

**Are the rare and threatened plant species colonizing the restored patches of Atlantic Forest?**

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The contribution of restored ecosystems to protect rare or endangered species has rarely been analyzed. Chronosequences of restored ecosystems can provide opportunities for this and other reliable predictions about the evolution of plant communities. Data from 26 restored riparian forests (aged 4-53 years) were compared with four pristine forests under the same environmental conditions, in the Atlantic Forest region, southeastern Brazil. All the native woody species in the reference ecosystems and those regenerating under the planted forests (1,000 m² sampled in each site, minimum height 50 cm) were recorded and classified as: 1- rare or common (Rabinowitz’s classification) and 2- threatened or not (red lists of threatened species). Of the 307 species recorded, 39% were classified as rare and 8.5% are in some threatened category. The number of rare or endangered species as well as their relative density in the restored forests tends to increase over time. The time estimated for the restored forests to reach the reference ecosystem is 95 years for the number of rare species (24 species), and 150 years for density of these species (3,390 plantsha-1). The number of threatened species (five) will take 40 years to be recovered and 85 years will be necessary to reach the density of these species (560 plantsha-1). The restored ecosystems have proven
Establishment of a species dispersed by birds: An example from a large-scale controlled restoration experiment

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Soil Conservation Service of Iceland

Safe sites and seed availability are the two main factors limiting establishment of plants. A controlled large-scale restoration experiment located at an eroded site in South Iceland offers an opportunity to assess the importance of those on establishment of Empetrum nigrum, a common bird dispersed heath species in Iceland. The experiment was established in 1999 with a range of inputs from fertilizer only to revegetation and planting of trees in 1 ha plots. The current study began in 2008 within two treatments and a control, and a third treatment was included in 2010. The reclamation treatments were: 1) sown grasses and fertilizer, 2) as 1 plus six clusters of birch and willows, and 3) fertilizer only. Empetrum plants were recorded for three years (autumn 2008-2010) determining their density and measuring crown diameters of each plant. No plants occurred in control plots and the establishment of Empetrum differed greatly between the reclamation treatments. The highest density and largest plants occurred in plots with clusters, and fewest plants occurred in plots receiving fertilizer only. Results indicated, however, that the establishment rate during the study was relatively higher in plots without clusters but fertilized and sown grasses. The reclamation treatments created safe sites and possibly also attracted seed dispersal agents. The study shows that restoration activities trigger changes resulting in relatively fast successional changes from a barren eroded area towards potentially a heath community.

Project Produtor de Água/PCJ: One of the first PES experiences in Brazil

Taffarello, Denise; Ricardo A. Goree Viani, Umberto Kubota, Aurélio Padovezi, Marta Chaim P. Portas
Secretaria de Estado do Meio Ambiente de São Paulo

The Produtor de Água/PCJ is a pilot Payment for Ecosystem Services (PES) Project under implementation since 2009 in the cities of Joanópolis-SP, Nazaré Paulista-SP and Extrema-MG, Southeastern Brazil. These municipalities are located within the PCJ Watershed and the Cantareira System, which supplies about 50% of the water demanded by the 20 million people of São Paulo Metropolitan Region. The Project is a partnership among federal, state, and local government institutions and non-profit organizations. The objective is to protect water resources by PES for rural landowners who voluntary adopt riparian forests restoration, forest fragments conservation and soil conservation practices. Payments are based on local land use opportunity costs and are proportional to the area of the property committed to the project. Resources for PES come from the water pricing by the federal PCJ Watershed committee. First PES contracts were signed in February 2011 and the project is currently with five contracts and 79 ha of land involved. These results are preliminary and we now expect an increase in the participation of landowners, since the first payment was recently done. The Project outlines advantages for water users and generates positive externalities at watersheds with environmental policies. Besides, it is also promoting conservancy and recovery of regional biodiversity and carbon sequestration. Based on these experiences, the São Paulo State Government developed the “Forest Remnants Program”, which includes the PES and regulates State Policy on Climate Change on areas where potential in providing environmental services is greater than economic potential for agriculture.

Adaptation options from ecohydrology and water footprint to the payment for ecosystem services in the context of river restoration projects in Brazil

Taffarello, Denise; Eduardo Mario Mendiondo
Secretaria de Estado do Meio Ambiente de São Paulo

We integrate ecohydrology criteria (Mendiondo, 2008) and water footprint (WF) assessment (Hoekstra et al, 2011) to the payment for ecosystem services (PES) in the context of river basin restoration goals in Brazil (von Glehn et al, 2011). Several PES projects are under implementation in Brazil through public-private partnerships for CO2 emission reduction, biodiversity protection and water resources restoration. However, a conceptual rationale is still lacking to link PES with ecohydrology processes and water footprint balances at the watershed scale under change, i.e until years 2050 and 2100. Ecosystem services are here enhanced by ecohydrological criteria of continuity, diversity, resilience, vulnerability and dynamics, through strategies and ecological processes of river active areas. A WF protocol is approached with accounting grey/green/blue components, sustainability assessment and response formulation at the scale of river/stream restoration projects. A new multidimensional model is developed from
Brazilian conditions to highlight the effectiveness of restoration projects, case studies and innovative management approaches from disturbed-to-restored settings. Quali-quantitative permanency curves, which incorporate WF from pollution goals and monitoring, are used to either understand or manage disturbed river/stream scales at longitudinal and cross-sectional areas. This spatiotemporal model acknowledges both predictive connections of local floodplain-channel ecohdrology interferences and WF adaptation options to long-term changes at the watershed scale. A Brazilian case from an ongoing research project (Marengo, 2011) performs yardsticks and participatory opportunities to communicate this novel approach to water users interested in adapting options for Brazilian watersheds under long-term change.

Desarrollo del plan de aprovechamiento comunitario de residuos sólidos orgánicos urbanos para la producción de composta en Cuernavaca, Morelos, México

Talancón Sánchez, Elisa del Rosario
Instituto de Ecología, UNAM

El manejo integral de los residuos sólidos urbanos es un servicio público altamente deficiente en México. En la ciudad de Cuernavaca, capital del estado de Morelos, esta deficiencia ha generado graves impactos ambientales: de las 400 toneladas de desechos sólidos que se generan al día, el 80% es almacenado en un relleno sanitario cuyo mal manejo impacta sobre los cuerpos de agua. El resto de los residuos es vertido a ríos y barrancas. Del total de los desechos sólidos el 35%, en peso, son orgánicos. El objetivo de este trabajo consistió en evaluar las posibilidades de integrar un plan de manejo comunitario de residuos sólidos orgánicos urbanos mediante la producción de composta. Se trabajó en dos colonias de la región: una de ingresos bajos y otra de ingresos altos. En ambas colonias se instaló un centro de compostaje, el cual fue operado en cooperación directa con los habitantes. Durante el desarrollo del proyecto, se analizaron las distintas formas de participación social adoptadas y las condiciones técnicas y económicas que definen el proceso de producción de composta: separación, recolección, tratamiento, distribución y consumo. A partir de los resultados obtenidos, se realizó un análisis de la viabilidad económica, social y política del proceso comunitario de producción de composta en base a un enfoque crítico de las relaciones capitalistas de producción en las que se desenvuelve.

Salvaging manzanita burls and chamise lignotubers for maritime chaparral restoration during munitions and explosives of concern (MEC) remediation

Tollis, Joshua
ARCADIS U.S.

Restoration in maritime chaparral is particularly challenging because of the slow growth and unpredictable precipitation. Some woody shrubs such as chamise (Adenostoma fasciculatum) and some species of manzanita (Arctostaphylos spp.) have adapted to drought (and fire) in part by forming below-ground lignotubers or burls. Working for the Fort Ord Reuse Authority, ARCADIS is implementing a Munitions and Explosives of Concern (MEC) Remediation Program at the Former Fort Ord in Monterey County, in coordination with the US Army; with oversight by federal and state regulators as required under CERCLA. As biological concerns are a critical component of the remediation program, ARCADIS on-site biologists tested salvaging of manzanita burls and chamise lignotubers. The challenge was whether the plants would survive the exposure during the time it took to complete the MEC remediation. Biologists simulated plant removal by heavy equipment and stored the bare root lignotubers/burls exposed without water for 0, 1, 4, or 10 days before planting them bare root in October, 2010. After 6 months the manzanita had 100% survival for the 0 day and 1 day exposure. The chamise had 75% survival for the 0 day treatment and 88% survival for the 1 day treatment. Both species had 100% mortality after the 4 and 10 day treatments. Our results demonstrate that lignotubers/burls of manzanita and chamise could be salvaged from sites similar to the former Fort Ord during MEC remediation as long the burls could be processed and planted within one day of removal.

Caracterización del uso actual del humedal de Ciénega de Cabezas, Tamasopo, San Luis Potosí, México

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The area of abandoned peatlands will increase drastically in forthcoming decades. There is an urgent need for rehabilitation of these areas with plants to restore carbon cycle balance and biodiversity. In this experiment the effect of fertilization on the productivity of lowbush blueberry (Vaccinium angustifolium) and on the chemical content of soil and groundwater in abandoned peatland was studied. Complex fertilizers (400 kg ha⁻¹) with different N content (2%; 6%; 14%) and lime (CaO + MgO, 67–71%) were used. The results showed that blueberry plants were growing successfully in bare peat ground, tolerating ecological conditions of abandoned peatland. However, in such nutrient deficient soil fertilization is necessary in order to ensure productivity. Application of complex fertilizers increased plant growth on average 128 % and by the end of the sixth growing year, the ground was almost covered with plants. High soil acidity was suitable for lowbush blueberry and liming could be considered unnecessary, since it was costly and plant growth was not affected. Fertilization also promoted the growth of other plants from genus Pinus, Betula, Eriophorum, Calluna. Hydrochemical analyses from drainage ditches around the experimental plots showed that nutrient content in the water was not higher than in the water from ditches, where no fertilizers were used in surrounding area. Fertilization increased soil potassium content in all treatments. Cultivating lowbush blueberry may become one alternative to restore vegetation in abandoned peatlands and fertilization did not damage soil and groundwater.
Beyond the event gave the cooperative members and reeducation sequence to work performing the review of the plantations, tutors, topdressing and coroamentos seedlings. With three months there have been accounting for 5% loss.

**Tree structure affects seed rain in a neotropical abandoned pasture**

**Tenório Leal Ramos, Danielle Christine; Wesley Rodrigues Silva**

Universidade Estadual de Campinas

Successful forest restoration depends largely on the addition of new plant species into a restored site, a process partially mediated by frugivores, whose attraction has been considered an important step in restoration techniques. Perches, natural or artificial, have long been demonstrated to be important factors in the increment of zoochorous seed rain. In an ongoing study in an abandoned pasture in southeastern Brazil we report the effect of tree structure on the zoochorous seed rain promoted by frugivores. Trees represented different botanical families with both zoochorous and non-zoochorous dispersal syndromes. Most of the zoochorous ones are well known for interacting with frugivores. Seed rain beneath non-zoochorous and zoochorous tree species showed no difference in both richness and abundance of seeds, even during the fruiting period of the latter group, suggesting that, at least in our study site, both zoochorous and non-zoochorous trees have similar probabilities of being used as perches by frugivores. Vegetation density in the vicinity of trees was positively correlated with the same seed rain variables. Tree height positively influenced both seed richness and abundance, possibly because tall trees are good lookout perches, from where food, friends and foes can be easily spotted. Seed abundance was also positively correlated with low canopy density, since less dense canopies allow seeds falling free to the ground. We conclude that tree structure should receive more attention when managing the attraction of frugivores to restoration sites.

**Conservation value – a practical method to select priority species for tropical forest restoration projects**

**Terra, Gilberto; Geovane Siqueira**

Vale Nature Reserve

The aim of the present study was to develop a method for prioritization of tree species in greatest conservation need to be used in restoration projects of the Brazilian Atlantic Forest. The method consists of a classification of the occurring species in the project’s phytogeographical region followed by a ranking based on the sum of values obtained for four selection criteria: conservation status, rare, endemism level and seed size of zoochorous species. Each species is scored in a scale from 0 to 8 in the ranking matrix, which corresponds to its conservation value (CV). When applied to the universe of 782 tree species of Vale Natural Reserve, in the State of Espirito Santo, it was found that species with a score equal to or greater than 3 are rarely reproduced in forest nurseries of the state, and therefore are not widely used in regional restoration projects which include seedlings planting. Combined with filling species, which typically have low CV but are essential to the success of projects, planting species with larger CV may result not only in the ecosystem restoration, but also in *in situ* conservation of rare, threatened and endemic species. The CV method has been used in hundreds restoration projects in the state of Espirito Santo, and can also be applied with minor adjustments to other forest types and life forms.

**The soil conservation service of Iceland – a century of land reclamation**

**Thorsson, Johann; Kristin Svavarsdottir**

Soil Conservation Service of Iceland

Iceland was settled in the 9th century. The 1100 years long human battle for existence has been fought against harsh natural conditions. Combinations of intensive non-sustainable land use and natural factors have resulted in vast land degradation and soil erosion. The peak of the ecosystem destruction was reached in the late 19th century, caused by the interaction of increasing size of livestock population and climatic fluctuations. Repeated disastrous events occurred including catastrophic sandstorms in the early 1880s. These disasters triggered some reactions against the destruction. In 1895, the first formal and organized measures aimed at curtailing erosion were taken by the Parliament. However, the effect of the passed legislation was negligible and of little value since it provided no means or incentives for erosion control. Eventually a new legislation was passed by the National Parliament in 1907 aimed at halting soil erosion and restoring lost and degraded woodlands and establishing the Soil Conservation Service (SCS), thus making it one of the oldest entities of its kind. Currently the SCS runs five district offices besides the headquarters in Gunnarsholt, South Iceland. Considerable milestones have been reached during a century of land reclamation efforts. Accelerated erosion has been stopped in many areas, resulting in new thinking. Today the
emphasis is on ecological restoration in close cooperation with farmers and local authorities, educating them on sustainable land use and land management.

**The degradation of Iceland**

**Thorsson, Johann; Asa L. Aradottir, Berglind Orradottir, Hlynur Oskarsson, Kristin Ssvarsdottir, Hafdis Hanna Aegisdottir**

Soil Conservation Service of Iceland

Land degradation is a widespread and ongoing problem in Iceland. Vegetated land cover in Iceland is estimated to have declined from 65% at the time of settlement in 874 AD to 45% at present. Birch (*Betula pubescens* Ehrh.) woodlands that once covered up to 30% of the land area now comprise only 1%. Today, barren deserts are estimated to cover 36% of the land area. Losses of vegetation have been accompanied by severe erosion. In many cases, soils of once-vegetated lands have been completely removed by wind and water, leaving only glacial till behind. The origin of these barren landscapes has been referred to as ‘ovigenic”, i.e. created by unregulated domestic sheep grazing. This is partially true, but the current situation probably reflects the outcome of four interacting and reinforcing factors: vegetation poorly adapted to grazing, soils (volcanic Andisols) highly susceptible to soil erosion, and environmental stresses associated with periodic volcanic eruptions and cold climate. Physical characteristics of Andisols (low particle cohesion, low bulk density and high water retention) make them highly susceptible to wind and water erosion. When these water-saturated soils freeze in winter, they markedly expand, thus destabilizing soil surfaces exposed to wind and water. This can trigger a positive feedback loop where further surface destabilizing increases degradation and erosion rates, which in turn increase surface instability. It is important to recognize these degrading processes before ecosystem functions are lost, causing an irreversible change in the landscape.

**Sacred Site Conservation**

**Tonenna, Dean**

US Bureau of Land Management

Sand Mountain, Nevada is one of the most sacred sites for the Native American Toetukadu people. The endemic biodiversity found within this dune ecosystem is exceptionally rare and is negatively impacted by motorized vehicles. The Bureau of Land Management (BLM), a U.S. federal agency, manages Sand Mountain as a recreational area and is also responsible for managing and protecting natural and cultural resources within the area. The increased popularity of Sand Mountain has led to fragmentation of the habitat with numerous unauthorized trails proliferating throughout the dune ecosystem. The BLM conducted a spatiotemporal study utilizing remotely sensed imagery to determine the extent and rate of habitat fragmentation and began a long term monitoring effort to better understand the impacts of motorized vehicles within the dune area. The agency met with tribal, recreational and environmental representatives to craft a strategy for restoration at Sand Mountain. Part of that strategy involved restoration of disturbed areas utilizing native plants having important cultural values to the Toetukadu.

**Análisis de Efecto Directo para determinar la toxicidad de sedimentos provenientes del área meridional de la Laguna Madre, Tamaulipas**

**Torres Cerón, Milton; Carlos Aguilera González, Antonio Leija Tristán, Jesús Montemayor Leal**

Universidad Autónoma de Nuevo León

Para el análisis de contaminación en sedimentos se sugiere realizar el Análisis de Efecto Directo que combina métodos químicos y toxicológicos: identificación de los contaminantes, realización de bioensayos con organismos bentónicos y el análisis de la comunidad bentónica. Se analizaron sedimentos provenientes del área meridional de la Laguna Madre, Tamaulipas, colectados durante diciembre 2009 y abril 2010, sometiéndolos a una serie de bioensayos de toxicidad sobre *Physa mexicana* y *Pomacea bridgesii*. El experimento se realizó en sistemas sedimento-agua a proporción 1:4, colocando 100ml de esta mezcla por gramo de organismo, a temperaturas de 25.8±3.143 °C y fotoperiodo de 12h luz/oscuridad. Para cada tratamiento se utilizaron tres repeticiones. Durante la exposición los organismos no fueron alimentados, considerando que estos tienen la capacidad de utilizar el detritus en el sedimento. El análisis químico reveló que los metales con mayor concentración fueron Fe (926.25mg/kg) y Zn (27.7mg/kg), mientras que los pesticidas organoclorados analizados mostraron concentraciones menores a 2mg/kg, la concentración de hidrocarburos pesados totales oscilo entre 100 y 200mg/kg. *P. mexicana* mostró mayor mortalidad (58.33%) al ser expuesto en sedimentos colectados en abril 2010 en el sitio denominado “El Barranco”; mientras que *P. bridgesii* mostró su mayor mortalidad (16.66%) al ser expuesto a sedimentos colectados en diciembre 2009 de la misma localidad. El Índice Biótico mostró una condición biológica de disturbio severo en el sitio “La Muela”, mientras que los demás sitios mostraron un grado menor de disturbio.
La Autopista Durango-Mazatlán es actualmente el proyecto carretero en construcción más importante del país. En Sinaloa el tramo carretero atraviesa del kilómetro 157+400 al 204+600; cruzando por la Sierra Madre Occidental, cuya orografía serrana se caracteriza por grandes barrancos y lomeríos, que representan un alto grado de dificultad para la construcción. El establecimiento de infraestructura, campamentos, caminos de acceso, bancos de tiro y préstamo, entre otras obras complementarias, además del cuerpo de la autopista, ha conllevado afectaciones al sistema ambiental, las que, aunadas con los cambios abruptos en los tipos de vegetación y suelo, representan un complejo escenario para la definición de las técnicas requeridas para restaurar cada superficie afectada; siendo necesario realizar análisis detallados y propuestas específicas para cada sitio. Dentro del programa de restauración ecológica se ha realizado el rescate de germoplasma nativo de los principales tipos de vegetación presentes: Bosque de Pino-Encino, Encinar y Selva Baja Caducifolia; al igual que el rescate de plántulas, epifitas, propágulos (estacas y esquejes) y recolección de semillas, con la finalidad de conservar y producir plantas propias de la región para su uso en la restauración. Los resultados arrojan una producción cercana a los 70 mil individuos de alrededor de 50 especies, junto con obras de conservación de suelo y control de erosión realizadas de forma paralela. Estas actividades en conjunto, son la base con la que se realizará la restauración ecológica de los sitios con el fin de recuperar los servicios ambientales mermados en las zonas de incidencia del proyecto.

Remoción de benzo[a]antraceno por cultivos puros de hongos y bacterias

Trejo Hernández, María; Arturo Dávila, Francely Almazán, Constanza Machín-Ramírez

Universidad Autónoma del Estado de Morelos

Los hidrocarburos aromáticos policíclicos (PAHs) son compuestos químicos que se encuentran en forma natural en el ambiente o que pueden introducirse a partir de fuentes antropogénicas. El benzo(a)antraceno (B[a]A) es un carcinógeno débil, de baja solubilidad y persistente. El B[a]A es considerado como contaminante prioritario por la Agencia de Protección del Ambiente (EPA) de Estados Unidos de América. Por esta razón, el propósito del presente trabajo fue el de evaluar el uso potencial de cultivos puros de bacterias y hongos para la biodegradación de diferentes concentraciones de B[a]A. Se realizaron ensayos de biodegradabilidad utilizando cultivos puros de 7 cepas diferentes de hongos y bacterias. Todos los hongos y bacterias fueron capaces de crecer en las 3 concentraciones probadas. Los porcentajes de remoción más elevados, en todos los casos, se obtuvieron a 25 ppm de B[a]A y cuando se utilizaron cepas fúngicas. El mayor porcentaje de remoción se obtuvo cuando se utilizó el hongo Trichoderma harzianum. En todos los casos pudo observarse un incremento en la concentración de biomasa transcurrido el período de incubación y no se observó remoción del contaminante en los controles abióticos. El uso de cultivos puros de hongos y bacterias puede considerarse como una estratega para el tratamiento de otros contaminantes prioritarios presentes en cuerpos de agua, sedimentos y suelos contaminados.

Remoción de benzo[a]pireno mediante el uso de cultivos puros y cultivos secuenciales de cepas fúngicas y bacterianas

Trejo Hernández, María; C. Machín-Ramírez, D. Morales Guzmán, F. Martínez-Morales, M.R. Trejo-Hernández

Universidad Autónoma del Estado de Morelos

Los hidrocarburos policíclicos aromáticos (PAH) son compuestos son altamente tóxicos y carcinogénicos. En este estudio, se evaluó la remoción de benzo[a]pireno, utilizando cultivos axénicos y cultivos secuenciales definidos fúngico-bacteriano. Las cepas utilizadas fueron: Aspergillus niger, Penicillium sp., Trichoderma harzianum, Saccharomyces cerevisiae, Serratia marcescens, Bacillus mycoides y Pseudomonas sp. Los porcentajes de degradación obtenidos variaron del 9 al 84% para los cultivos fúngicos, y del 1 al 35% para los cultivos bacterianos. La mayor velocidad de degradación en todos los tratamientos se alcanzó consistentemente por las cepas fúngicas y en general, se encontró que los cultivos puros, tanto de hongos como bacterias, fueron más sensibles a las variaciones en la concentración del contaminante. Cuando se utilizaron los cultivos secuenciales, se obtuvo la mayor remoción de benzo[a]pireno (65%, 50 mg/L) con el cultivo constituido por Penicillium sp./Serratia marcescens. Nuestros resultados muestran que el uso de cultivos fúngicos fue siempre más efectivo para la biodegradación del benzo[a]pireno que el uso de cultivos bacterianos, aún cuando las concentraciones del contaminante se triplicaron.
Más aún, se muestra que el uso de un cultivo secuencial definido fúngico-bacteriano puede incrementar la biodegradación del benzo[ap]pireno. Esta estrategia biológica puede ser utilizada para remoción de otros hidrocarburos policíclicos aromáticos persistentes presentes en cuerpos de agua, sedimentos y suelos contaminados.

**Monitoreo de bioindicadores de calidad ambiental de un humedal tropical del Sureste Mexicano**

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El objetivo del estudio fue evaluar la calidad ambiental del Pantano de Santa Alejandrina en Minatitlán, Ver., afectado por residuos de hidrocarburos, mediante su relación con los índices ecológicos de las comunidades de flora y fauna. En 2004 se llevaron a cabo tres campañas de muestreo de suelo y colecta biológica de campo, en tres zonas con residuos y una de referencia del pantano, efectuando el cálculo de los parámetros ecológicos de las comunidades, así como del análisis de varianza y de discriminante canónico con el programa SPSS V.11. Con base en los parámetros ecológicos calculados para las comunidades vegetales y faunísticas estudiadas: aves, mamíferos, anfibios y reptiles, artrópodos y de microartrópodos, fue evidenciado un gradiente de calidad entre las zonas impactadas y la de referencia. Se observó perturbación importante en dichas zonas, motivo por el que algunas especies sensibles presentan tanto baja abundancia como biodiversidad, dominando únicamente especies tolerantes. En tanto que en la zona de referencia, no se observó la dominancia de alguna especie en particular y se presentó alta biodiversidad. Con estos resultados se contó con elementos para determinar la calidad ambiental y orientar actividades de recuperación del ecosistema con base en la estructura ecológica. Asimismo fue posible seleccionar organismos bioindicadores por sensibilidad o tolerancia a los residuos, lo que permitirá dar un seguimiento de la recuperación y restauración ecológica del pantano, una vez retirados los residuos.

**Efecto de arbustos nodriza y protectores arbóreos en el establecimiento de Austrocedrus chilensis y Maytenus boaria en un sitio semiárido de la Patagonia argentina**

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Centro de Investigación y Extensión Forestal Andino Patagónico

Se evaluó el efecto de la cobertura natural de arbustos nodriza y la cobertura artificial de protectores arbóreos en la supervivencia y micro-ambiente de dos tipos de plantines de Austrocedrus chilensis y uno de Maytenus boaria, en un sitio semiárido de la Patagonia Argentina (Latitud 42°55’S-Longitud 71°15’W). En invierno de 2006 se establecieron 30 plantines por tipo de plantín y cobertura (a-cobertura natural de arbustos nodriza (NOD) del género Berberis, b-cobertura artificial de protectores arbóreos de polipropileno (PA) y c-sin cobertura como control (CO)). Se evaluó supervivencia al primer y segundo año, y se midió la temperatura superficial y la humedad de suelo durante la primera estación de crecimiento. La supervivencia del primer año fue independiente (p>0,05) de la cobertura en los tres tipos de plantines pero fue mayor en un tipo de ciprés (80% vs. 50 %). Luego de la segunda estación de crecimiento de condiciones muy secas, la supervivencia disminuyó en los tres tipos de plantines permaneciendo mayor en NOD y PA que en CO. La temperatura del suelo superficial fue mayor (p>0,05) en CO y la humedad fue distinta al inicio (NOD=PA>CO) final (PA>NOD=CO). La utilización de protectores arbóreos en áreas desprovistas de vegetación que pueda facilitar el establecimiento se estas especies, se presenta como una alternativa técnica viable para la restauración de estos bosques.

**Selección del sistema silvíceno en plantaciones de coníferas exóticas para la restauración ecológica de bosques templados mixtos de Austrocedrus y Nothofagus en Patagonia Argentina**

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En Patagonia Argentina las plantaciones de coníferas exóticas establecidas antiguamente en áreas de bosque nativo, son potencialmente invasoras de los bosques mixtos de Austrocedrus chilensis y Nothofagus dombyei, con gran riesgo de impacto ambiental a mediano y largo plazo. El objetivo de este trabajo es seleccionar la intervención silvícena que, imitando el régimen de perturbaciones naturales de estos bosques, sea adecuada para generar condiciones bajo el dosel de las plantaciones que favorezcan el establecimiento de las especies originarias plantadas con fines de restauración. La intervención silvícena por el método de tala rasa en fajas y bosquetes se realizó en un rodal de Pinus contorta (Parque Nacional Los Alerces). Se estudió la radiación fotosintéticamente activa en ambos tipos de intervenciones, diferenciando las posiciones Norte, Centro y Sur, y su asociación con la supervivencia y crecimiento de plantines de Austrocedrus y N. dombyei. La radiación fue menor en el Norte, mientras que el
crecimiento fue similar para todas las posiciones de ambas intervenciones. Al finalizar el primer año de estudio, la supervivencia no se asoció con la radiación, lo cual podría deberse a la baja mortalidad presentada, y el crecimiento de ambas especies tampoco estaría asociado. Los resultados obtenidos estarían indicando que el efecto del tipo de intervención es similar al primer año. Dada la longevidad de las especies consideradas es necesario continuar con el estudio para definir la intervención adecuada.

**Propuesta de saneamiento integral para tres comunidades en la cuenca del río Cuíztzmalac, Jalisco, México**

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El río Cuíztzmalac localizado al sureste del estado de Jalisco es la principal fuente de abastecimiento de agua para esta zona tropical. Predominan en la cuenca poblados rurales, pequeños, enfocados a actividades agropecuarias. La evaluación de calidad del agua resulta prioritaria para esta región con estaciones de sequía y lluvias marcadas. Análisis físicoquímicos de calidad de agua indican que las zonas de descarga en los poblados requieren de seguimiento pues algunos valores superan lo sugerido por Normas Oficiales Mexicanas. Se realizó una encuesta que muestra que el agua de mayor consumo es embotellada, mientras que para servicios se utiliza agua superficial entubada. Para mejorar la calidad del agua de río la gente coincide en la necesidad de contar con drenaje y un sistema de tratamiento de aguas residuales. Parámetros como temperatura y oxígeno disuelto responden a características medio ambientales y topográficas. Parámetros microbiológicos y nutrientes están asociados a actividades productivas y domésticas de cada localidad. De acuerdo con los resultados de calidad de agua, el río presenta una autodepuración, pues en los puntos anteriores y posteriores a los poblados presenta una buena calidad, con valores similares. Los drenajes y fosas sépticas con los que cuentan las localidades son insuficientes, pues al no contar con un sistema de tratamiento de aguas, todos estos desechos llegan al río de manera directa, esto se ve reflejado en sus altos niveles de bacterias indicadoras.

**Establecimiento de especies nativas para la restauración de la subcuenca del río Cupatitzio**

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La subcuenca del río Cupatitzio, en las últimas décadas ha sufrido la pérdida de la cubierta vegetal, las principales causas han sido el cambio de uso de suelo, introducción de especies exóticas e incremento de áreas de cultivo (i.e. aguacate). Estas modificaciones han ocasionado que especies nativas sean desplazadas por especies exóticas, trayendo como consecuencia la modificación en la composición y estructura vegetal, ocasionando una disminución de la calidad del suelo e infiltración del agua. Debido a lo anterior es importante desarrollar estrategias que permitan la integración de los ambientes naturales a sitios con perturbación por factores de origen antropogénico. Por lo que este proyecto tiene como objetivo establecer especies nativas que puedan ser empleadas para la restauración en sitios con algún grado de perturbación. De forma aleatoria se determinaron 18 sitios de muestreo, donde se caracterizó a la comunidad de plantas y se realizaron colectas botánicas de los ejemplares a lo largo de la subcuenca. Con base a la estructura y composición de la comunidad, el valor de importancia de cada una de las especies y su valor morfológico se establecieron 44 especies de plantas nativas. Las especies determinadas pertenecen a especies leñosas correspondientes al área, las cuales satisfacen la demanda tanto ambiental como paisajística y permiten contribuir a la recuperación de corredores bilógicos, recuperación del suelo y mejoramiento de la calidad del agua.

**Ecological restoration of the “Loma de Santa María” protected area: The importance of coordinated efforts**

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Consultor Independiente

The natural protected area, Zona de Restauración y Protección Ambiental Loma de Santa María y Depresiones Aledañas, within the city of Morelia, Michoacán, México, is an important area for biodiversity conservation and is one of the most important public parks in the city. Within the protected area remnants of different vegetation types can be found, including oak forests, riverine vegetation and tropical dry forests, mixed with plantations of both native pines and exotic eucalyptus trees. Because of the long story of human impact, a Restoration Plan was elaborated following the State’s environmental law (Ley Ambiental y de Protección del Patrimonio Natural del Estado de Michoacán) and following SER guidelines for restoration. The restoration plan was made by private consultants and revised by academics. The plan has been complemented by Office of Urbanism and the Environment of the State of
 Michaocán. One year after work began it was possible, working with local landowners, to remove cattle from the protected area. Also, six native tree species have been planted in the area: Pinus michoacana, P. lawsoni, P. leiothyalla, P. oocarpa, Albizia plurijuga, Fraxinus udhei, Prunus serotina, with an average survival of 44%, value within expectations. Soil protection measures included the construction of 269 trenches and 800 m of derivative ditches. Also 2,759,509 seeds from 20 native species were collected through coordinated efforts of public and private institutions, as well as local inhabitants. We discuss the importance of coordinated efforts to foster restoration in urban areas.

**Ecosystem restoration and integrated watershed management in Port-á-Piment, Haiti**

**Varga, Alexandra; Garance Denizot, Alexander Fischer, Marc Levy**

Haiti Regeneration Initiative

With only 2% of its original forest remaining, the Haitian ecosystem continues to deteriorate, lose critical productivity and become more vulnerable to disasters. The Haiti Regeneration Initiative (HRI) is a joint program led by the UN Environment Programme (UNEP), the Earth Institute, and Haitian partners which aims to design integrated watershed management programs that will combine reforestation, agro-forestry, sustainable energy, and flood risk management activities. After one year of preparatory work, the HRI is collecting and analyzing data to measure soil degradation and understand hydrological processes in the Port-á-Piment watershed. Reforestation and afforestation are commonly known for their ability to reduce erosion and damages due to floods. However, despite years of large scale reforestation efforts, projects have largely failed to connect flood risk models with evidence on how shifts in land cover and vegetation impacts those models. The objectives of this study are to (1) review the literature on integrated models for hydrodynamics, land cover characteristics, erosion, land use and soil characteristics, (2) identify the tools and methods that could be applied to the case of the Port-á-Piment watershed based on existing data and research programs, and (3) make recommendations on additional data that should be collected for enhanced modification. The present study is based on a bibliographical review, ongoing data collection and interviews with experts across disciplines. Amongst others, hydrological models, tree water absorption studies, reports of previous reforestation attempts will be analyzed in order to propose the most appropriate methodology for the HRI to follow.

**Protection of endangered bog pine (Pinus uncinata subsp. uliginosa) in the Czech Republic**

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Silva Tarouca Research Institute for Landscape and Ornamental Gardening

The bog pine, Pinus uncinata subsp. uliginosa (Neumann) Businsky, the taxon sub endemic in the Czech Republic, forms only two main distribution areas situated in southern and western Bohemia. In both locations, the taxon purity is endangered because hybridization with other pine species (especially with Pinus sylvestris) is common. The lowest situated and most isolated locality of the bog pine population is found in the peat bog Natural Reserve "Borkovická blata" in southern Bohemia (altitude around 420 m a.s.l.). The objective of the work was to use selected genetic markers to verify the genetic purity of bog pine individuals and afterwards to derive in vitro cultures. The plastid DNA analysis was used as a molecular-genetic tool. All the tested individuals from the studied population matched the Pinus uncinata subsp. uliginosa haplotype. In genetically verified bog pine, development of axillary shoots was significantly enhanced on Westvaco WV5 (Duchefa) media containing a high concentration (5–10 g/L) of activated charcoal and no growth regulator at all. In vitro gene bank of P. uncinata subsp. uliginosa individuals was established for reproduction and conservation purposes.

**Effects of rodent eradication on breeding seabirds of Isla Rasa, Gulf of California, Mexico**

**Velarde, Enriqueta; Exequiel Ezcurra, Juan Pablo Gallo, Enrico Ruiz, Andrés Aguilar, Gerardo Ceballos**

Instituto de Ciencias Marinas y Pesquerías

Rodent eradication in Isla Rasa, a Mexican federal protected area, resulted in increase in colony size, breeding success and species diversity of seabirds. Rasa Island is less than 1 km², located in the northern Gulf of California, and harbors the largest nesting colonies of both Heermann’s Gull (Larus heermanni) and Elegant Tern (Thalasseus elegans) with about 95% and 90% of each species (presently some 260,000 and 200,000 individuals respectively), plus the largest colony of nesting Royal Terns (T. maximus) in the Mexican Pacific (17,000 individuals). There are reports of Craveri’s Murrelet (Synthliboramphus craveri) and Black-vented Shearwater (Puffinus opisthomelas) nesting on the island in the late 19th and early 20th Century, when guano harvesting started in Rasa Island, and both black and Norway rats (Rattus rattus) and house mice (Mus musculus) were introduced. After that, there were no
subsequent records of the two latter seabird species in Rasa. All four seabird species are listed as Vulnerable or Threatened under Mexican federal environmental law. In 1995 Jesus Ramirez coordinated a successful rodent eradication program in Rasa Island, the first successful program of introduced species on islands in Mexico. Since then the breeding success of the Heermann’s Gulls has increased, the Elegant Tern breeding colony has increased fourfold and there have been records of nesting Black-vented Shearwaters and possibly also of Craveri’s Murrelets, plus two new plant species have been recorded. Despite on site protection and public awareness, the most dramatic effects on nesting seabird numbers and species diversity occurred after rodent eradication.

**Seabirds of Arrecife Alacranes, Mexico: Baseline data before rodent eradication and oil spill effects**

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Instituto de Ciencias Marinas y Pesquerías

Arrecife Alacranes, the northernmost reef zone of the Gulf of Mexico, harbors the largest nesting seabird concentrations of the region (ca. 70,000 nests), and is a Mexican federal protected area. Some important threats to the area are oil extraction, introduced species (main cause of extinction in islands), fisheries, and tourism. Black rats (*Rattus rattus*) and casuarina trees occur in Isla Perez, one of the reef’s islands, and a plan for the rodent eradication is under way. The last seabird census reported was done in 1986. In May and August 2009 we made surveys to monitor their present populations. Direct nest counts were carried out, with complementary counts on photographs. The total nests found per island were: Perez: 139,116 *Sterna fuscata*, 1,039 *Anous stolidus*; Muertos: 827 *Sula dactylatra*, 10 *S.sula*, 50 *Fregata magnificens*; Pájaros: 64 *S.dactylatra*; Chica: 22 *S.dactylatra*; Desterrada: 82 *S.leucogaster*. Our information revealed much larger numbers than those previously reported for *S. fuscata*, *S. dactylatra*, and *S. sula*, but less for *F. magnificens*. Protection of the area could be one factor to explain the increment in the seabird nesting numbers, and it will be interesting to see what changes occur after the rodent eradication is carried out, but also, effects of the BP oil spill may be detected.

**Soil natural capital restoration in New Zealand soil narratives**

Vesely, Eva-Terezia

Landcare Research

Semi-structured interviews were conducted to explore current soil narratives in New Zealand. Interviewees were experienced and knowledgeable from a range of agencies encompassing regional and national government, businesses, research, education and the non-profit sector. A dominant perception held by the interviewees was that soils underpin our agricultural production systems, position in international markets, native ecosystems, community gardens, greenroofs, and harbour water quality. However, we only tend to see the grass, the kiwifruit, the kauri, the pumpkin, the New Zealand iris or the mud; the soils remain mostly invisible. The relatively new concepts of soil natural capital and associated ecosystem services provide us with a new lens to look at soils and their restoration, and provide a framework to make soils more visible. The thematic analysis of the interview material revealed various levels of awareness of the concept of soil natural capital, a range of interpreted meanings, as well as a series of advantages and disadvantages attributed to its use. It also revealed a series of interpretations of soil restoration, opportunities and barriers for its implementation including the role of soil valuation in soil management decision making. The findings from these interviews are related to the published literature on the definition and quantification of soil natural capital. This allows for an investigation of the tension between the revealed richness of the concept and the expectation for standardisation expressed by both the interviewees and the authors. A proposal is suggested to resolve this tension by linking the context of use with matching definitions using restoration as an example.

**Effects of nucleation techniques on forest restoration in abandoned pastures, southeastern Brazil**

Viani, Ricardo; Ricardo Gomes Cesar, Aurélio Padovezi

The Nature Conservancy, Brazil

Forest restoration in large abandoned pastures requires low cost techniques that facilitate natural regeneration and effectively control invasive grasses. Monitoring and evaluation of such techniques is essential to guide future forest restoration activities. This study was carried out in Piracaia, São Paulo state, southeastern Brazil, in an abandoned pasture where natural regeneration was assisted and small seasonally dry Atlantic forest fragments occur. We analyzed the effect on tree and shrub natural regeneration and invasive grass coverage of four nucleation techniques: planting of native trees in groups, artificial bamboo perches, branch piles and jute sacks filled with seeds and manure. Data were gathered in paired plots, one located exactly in the nucleation technique and one control plot adjacent to
the nucleation technique. Invasive grass coverage was lower in all nucleation techniques than in the respective control plots (paired t test, p<0.05). Jute sacks had more individuals and diversity regenerating than their control plots; perches and branch piles had less individuals but more diversity than controls and tree group planting had less diversity and much fewer individuals regenerating than their control plots. The results of all four techniques were modest, perhaps because data were collected only ten months after the initial intervention. Additionally, we could not discriminate whether the differences observed were due to the nucleation techniques themselves or the hoeing in the nucleation plots before implementation. In a future study, nucleation techniques will be compared with other restoration techniques used in adjacent areas.

Tree nurseries and seed collecting in service of tropical forest restoration: How to increase their biodiversity and potential for social integration?
Viani, Ricardo; Pedro H.S. Brancalion, James Aronson, Ricardo R. Rodrigues
The Nature Conservancy, Brazil

High-diversity reforestation can help jumpstart tropical forest restoration, but obtaining viable seedlings is a major constraint: if nurseries do not offer them, it is hard to plant all the species one would like. From 2007 to 2009, we investigated five different seed acquisition strategies employed by a progressive tree nursery in SE Brazil, namely i) in-house seed harvesters, ii) hiring a professional harvester, iii) amateur seed harvesters, or iv) a seed production cooperative, as well as v) participating in a seed exchange program. Additionally, we evaluated two strategies not dependent on seeds: harvesting live seedlings from desirable native tree species found regenerating under Eucalyptus plantations, and in a native forest remnant. A total of 293 native tree and shrub species, and 2,465 seed lots, were obtained over the three year period. Among these, a subset of 120 species was obtained repeatedly in each year. Overall, hiring a professional seed harvester, participating in a seed exchange program, and harvesting seedlings in a forest remnant supplied more species and ‘exclusive’ species, i.e., not supplied by any other strategy, than the two other approaches. Additionally, by combining seed acquisition methods a higher number of seed lots per species was obtained, thereby enhancing genetic diversity as well as increasing species richness. We discuss ways to improve seed harvesting and production techniques, as well as the opportunities and risks related to developing the potential for remunerated seed and seedling harvesting in order to foster greater community participation in restoration programs.

Regional-scale patterns in species richness in restored areas of the Atlantic Forest, Brazil: High floristic heterogeneity promoting high regional diversity
Viani, Ricardo; F.A. Carvalho, P.S. Brito, L.M. Alves, R.M. Benini, A. Padovezi
The Nature Conservancy, Brazil

Understanding the patterns of natural regeneration in areas under restoration is important to better predict the outcomes of tropical forest restoration techniques. This study seeks to analyze the floristic heterogeneity of natural regeneration in areas restored by tree seedling planting and by the enrichment planting techniques. We evaluated about 200 ha of early secondary patches of Atlantic Forest restored by The Nature Conservancy’s Plant a Billion Trees campaign in the region of Juiz de Fora, Minas Gerais, southeastern Brazil. 184 plots of 3x5 m (0.28 ha) were randomly located in the study areas. Within plots, all trees with height ≥0.3 m and diameter ≤5 cm at 1.3 m were sampled. We created a quantitative matrix with the 38 plots containing ≥10 trees sampled, and used a Jaccard similarity index as a measure of beta diversity. We found a low floristic similarity between plots, with only 21% of plots having a similarity higher than 50%. The richness value projected by the second order ‘Jackknife’ estimator was 218 species, while real richness measured in the plots was 106 tree species. This suggests that plots have a high potential to increase regional richness over space and time. Moreover, our results indicated high beta diversity (high dissimilarity) associated with high projected richness. Areas under restoration are floristically heterogeneous and have a high potential for natural regeneration. Finally, our results demonstrate that the restoration techniques being used are promoting initial recovery of the high floristic diversity at regional scales.

Uses of artificial seed dispersion units in ecological restoration the Amazon
Vieira, Gil; Jutta Blauert, Heidi Asbjornson
IDEAS Comunitarias

The Mixteca Alta is a mountainous region in the southeastern Mexican State of Oaxaca. A long history of over-grazing by goats and sheep under transhumance management, combined with other land use activities, has resulted in severe land degradation. Over the past 25 years a local farmer group, ‘CEDICAM’, has worked with resident
communities to mitigate and reverse this degradation. CEDICAM applies an integrated model to restore degraded lands, which involves strengthening initiatives by community actors and social institutions of local communities to enable them to efficiently manage their natural resources to achieve sustainable livelihoods. The paper reports on findings from interdisciplinary research and of an ARIDnet workshop in partnership with CEDICAM and local stakeholders to assess drivers of land degradation in this region and for restoration processes. We explore whether interventions in soil conservation and reforestation by CEDICAM have been successful in achieving significant progress towards reversing the processes of desertification and consolidating community-based initiatives of restoration thereby improving social capital and environmental quality, particularly related to water supply, agricultural production and food security. One of the key methodological axis used is the DDP (Dahlem Development Paradigm) to evaluate perceptions and needs of local communities, and to identify key ecological and socio-economic drivers of desertification and restoration. Two models evolved: one provided a historical depiction of the dominant drivers—and their interactions—while the second provided a framework for restoring degraded lands based largely on CEDICAM’s model.

Litter influence on nutrient dynamics in Atlantic forest regenerating species under eucalipt plantations

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Native Brazilian forests were removed to establish artificial plantations. The widespread replacement of natural heterogeneous forests by introduced forest monocultures produced environmental problems. Since eucalipt leaves are the bulk of the leaf litter it was hypothesized that the litter may retard regeneration of native species under those plantations, causing nutritional limitation. The aim of the present study was to investigate the impact of litter layer removal on soil, leaves and litterfall nutrients of Atlantic forest regenerating species under abandoned eucalipt (Corymbia citriodora) stands at União Biological Reserve, Rio de Janeiro, Brazil. The study was carried out in two eucalipt stands abandoned since 1996. Litter has been removed monthly since 2004 in five plots (5mx20m). Samples were collected in the dry and wet seasons of 2008-2010. There was a negative effect of litter removal on soils macro and micro nutrients at least in one of the stands or seasons. The lower soil C/N ratio in response to litter removal confirms that the absence of eucalipt leaves increases organic matter quality. However, litter removal did not clearly affect leaf nutrients. Litterfall tends to decrease with litter removal in the youngest stand, as a response of eucalipt leaves which are the bulk of the total litterfall. The time required for nutrient status response on plants is longer than on soils, explaining the differences in nutrient patterns among compartments. This is part of a long term project to entirely understand the effects of C. citriodora on Atlantic forest species regeneration.

Frugivorous bats in secondary forest under traditional management, Lacanhá Chansayab, Chiapas, Mexico

Vleut, Ivar; Samuel Levy Tacher
El Colegio de la Frontera Sur

The farmers from the indigenous community of Lacanhá Chansayab have developed strategies for the sustainable use of slash and burn management. The matrix of Lacanhá consists of mature vegetation, with small patches of 0.5-1.0 ha of agricultural fields and secondary forest. The composition of dominant tree species can vary, due to the diversity of tree species available in the area, but also because of the farmer’s preference for certain species. Therefore, areas of secondary forest dominated by Belotia mexicana, Swietenia mahagoni can be observed, as well as the preference for one species in particular; balsa (Ochroma pyramidale - Malvaceae). O. pyramidale, is known for its fast growth, fast leaf turnover, capacity to enrich depleted soils or rehabilitate degraded areas caused by frequent fires. The size and the fast turnover of the leaves of O. pyramidale can be a factor which limits the possibility of seeds passing the layer of leaves and therefore the germination of plant species. The layer of leaves limiting plant germination can have consequences for the diversity of plants and thus fruits that can attract frugivorous bat species. We studied the ensemble of frugivorous bat species and its diet in areas of secondary forest dominated by O. pyramidale and in areas of secondary forest with a diversity of tree species. We expect that the diversity of canopy trees and understory plants in secondary forest areas affect the diversity of frugivorous bat species.

Invasive species management: How do common herbicides affect seed performance?

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Herbicides are a frequently applied tool in invasive species management on account of their cost-effectiveness. Restoration practitioners and scientists evaluate herbicide impacts on target and non-target plants by inspecting conspicuous plant traits, such as aboveground cover or the production of flowers and fruits. However, how herbicides affect seeds following dispersal has received little attention in restoration ecology, despite the crucial role played by the seed bank in population and community dynamics. I conducted a meta-analysis of studies to collate data on the effects of common herbicides used in invasive species management on seed viability and germination. The results shed light on broad patterns across functional and taxonomic groups and range from negative to neutral or even positive effects. Some broad knowledge gaps are identified. Impacts on seed banks need to be taken into consideration when herbicides are applied to manage invasive plants.

River and riparian zones restoration and revitalization within Brazilian Atlantic Forest
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Universidad Autónoma de San Luis Potosí

The Mata Atlântica or Brazilian Atlantic Forest (MA) is considered one of the 5 hotspots of biodiversity in South America. Not only holds significant species richness but also a high rate of endemism. Simultaneously, sustains the great majority of Brazil’s population and economy. Since its exploration and colonization, the forest was deforested up to a 12% of its original extent. Ecosystem restoration is a growing field of knowledge and practice. The increasing awareness of ecological processes and the services they provide to human societies supports greatly this advancement. In particular, a healthy riverine environment includes ecological processes which intervene in improving water quality, in a form that from man’s view is highly cost-effective. The DinaRIO project aims to increase existing knowledge on landscape dynamics and resource use in the MA. It’s carried on by Cologne University of Applied Sciences among other European universities and Brazilian resource administration institutions. Its chapter on water resources management includes a revision of the riverine environment state and perspectives. The purposes of my work, framed in DinaRIO Project, are (1) to review the European experience of river restoration, and select those cases which provide technical experience which may be of effective use within MA; (2) Evaluation of the riverine environment in the area of the MA where DinaRIO Project takes place (Macacu and Guapi-Açu watersheds); and (3) establish a set of measures to be taken in the field of river restoration in order to revert present degradation course.

Seed dormancy breaking and germination of three native shrubs in cold desert: Implications for restoration
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Successful restoration of degraded desert is limited by lack of information regarding reintroduction of native shrubs that tolerate drought. While using seed is common for desert restoration, little is known about the germination characteristics of most native shrubs. We present the results of a study on breaking seed dormancy and germination requirements for two Atraphaxis species and one Caragana, which are common to cold deserts in temperate Northwest China. Conditions for breaking seed dormancy and germination were investigated to determine the optimum combination for maintaining seed viability and stimulating germination rates over time. Seeds of each species were placed under three storage regimes: dry-cold, dry-room and in the habitat soil (wet-cold). Seeds were stratified at 5/1°C and incubated at 12/12 h daily temperature regimes of 16/5, 20/10, 25/15 and 30/20°C. Seeds of the two Atraphaxis species are dormant at maturity, they showed the greatest germination response at test temperatures after wet-cold storage for 6 months. For Atraphaxis spinosa, seed dormancy was not broken after dry-cold and dry-room storage. And for Atraphaxis virgata, final germination percentage at 15/6°C were, respectively, 99% and 80% after 6 months of dry-cold and dry-room storage. Germination percentage of freshly matured seed in Caragana acanthophylla were about 50%, scarified seeds germinated rapidly to 100% after two weeks of incubation at higher test temperatures (30/20, 25/15°C).

Introduction to management plan by long-term monitoring on degraded estuary ecosystem by coastal development around Nak-Dong River, Korea
Yoon, Gon Tak; Heung-sik Park, Man Chang
Korea Ocean Research & Development Institute

Nakdong River, located in South Korea, has a typical estuary with diverse habitats such as marshes and developed sand bar. It has been experiencing the development of city, industrial and port facilities expansion. Since the barrage,
which is close to the estuary, was completed in 1987, the functions of estuary have been adversely affected. Based on short-term changes, the dominant species as well as habitats differentiated distinctly close to the mouth of the river before and after the construction of barrage, are characterized by modest changes. But now, because of climate changes and lots of discharges through the barrage, the government set up a management plan to control the discharge considering the estuaries and an integrated ecosystem model. We introduce to the management plan based on long-term monitoring of benthic habitats and considering restoration of the developed estuary area.

**Construction and application of the coupling model during ecological restoration process of degraded ecosystem**

**Yu, Yina; Peng Shaolin**

South China Agricultural University

Research on coupling ecological restoration with economic systems is important for the establishment of an efficient and sustaining ecological restoration economic system. The degree of coupling can clarify the interactive relation between ecological restoration and restoration economic systems and be used for evaluating the stage of the ecological restoration economic systems. Based on the data from degraded ecosystems of Xiao Liang Guangdong Province, we established a coupling factor model for the ecological restoration and ecological restoration economic systems, calculated and analyzed the degree of coupling over last 45 years. It reflects the ecological economics dynamic coupling process of degraded ecosystems and confirms the critical point at which ecological restoration economic systems impacted ecological restoration systems. This has important practical significance for developing and utilizing ecological restoration resources and making sustainable development plans for ecological restoration economic systems.

**Restoration of benthic macrofauna after crude-oil pollution on a sandy beach in Korea**

**Yu, Ok Hwan**

Korea Ocean Research & Development Institute

Seven months after the December 2007 Hebei oil spill off the Korean coast, most polluted sandy beaches had been cleaned by removing the oil and the underlying sand and were reopened to the public. However, little attention has been paid to the recovery of the macrofauna living in oil-impacted sandy beaches. Investigations on the macrobenthos in sandy beaches were conducted from January 2008 to January 2010 to assess the restoration of the macrobenthic community after the oil spill. The studies were conducted seasonally at two oil-impacted areas, Shinduri and Mallipo, and at two unpolluted areas, Yunpo and Mongsanpo. A year after the oil spill, the density and biomass of macrobenthos in the impacted area had increased significantly, but diversity was little changed. Macrobenthos density in the oil-impacted area had increased above that in the unpolluted area by October 2009. The number of species in the oil-impacted area, however, was twofold less than that in the unpolluted area. Numbers of the most dominant gastropod, *Felaniella sowerbyi*, increased dramatically after 9 months but only appeared in the oil-impacted area. The amphipods *Eohaustorius spinigerus* and *Urothoe grimaldijaponica*, which had dominated at Shinduri before the oil spill, were nearly restored 24 months later, but polychaetes and crustaceans did not reach baseline populations. Cluster analysis showed that the macrobenthic community in the oil-impacted area was distinct from that in the unpolluted area after January 2009, and this distinction remained 36 months later. This study suggests that a macrobenthic community may require a longer period for restoration and resettlement than commonly thought.

**Regeneración natural de mangle negro (Avicennia germinans) en un sitio de restauración ecológica de Yucatán, México**

**Zaldívar Jiménez, Arturo; Rosela Pérez-Ceballos, Jorge Herrera-Silveira, Claudia Teutli-Hernández, Tomas Zaldívar-Jiménez, Ricardo Ortega, Juan Caamal Sosa, Teresa Andueza**

UNIDO-CINVESTAV Unidad Mérida

La costa yucateca presenta varios sitios de manglar degradados a consecuencia de cambios hidrológicos y por efecto de huracanes. En un área de 15 ha de manglar degradado se realizaron acciones de restauración para rehabilitar la hidrología. Este sitio fue usado en tiempo atrás como zona de tiro de materiales de dragado de marinas. El desazolve de canales de marea fue la principal acción de restauración. Después de las acciones se registro el establecimiento natural de plántulas de mangle negro. La densidad de plántulas en el sitio de restauración fue entre 0.2 y 0.6 plántulas m⁻² comparado con un sitio de referencia de manglar natural de con 2.7 plántulas m⁻². La tasa de elongación del tallo fue entre 0.08 y 0.13 cm día⁻¹ en el sitio de restauración comparado con el sitio de referencia con 0.05 cm día⁻¹. Los
La regeneración natural como indicador de éxito de este proyecto sugiere que la rehabilitación hidrológica es la estrategia a seguir en los manglares degradados de Yucatán.

Programa piloto de restauración ecológica de manglares dentro del proyecto del Gran Ecosistema Marino del Golfo de México

Zaldívar Jiménez, Arturo; Jorge Herrera-Silveira, Rosela Pérez-Ceballos, Claudia Teutli-Hernández, Porfirio Álvarez-Torres, Luis Enrique Amador, Esthela Éndañu, Emma Guevara Carrió
UNIDO-CINVESTAV Unidad Mérida

El proyecto de Evaluación Integral y Manejo del Gran Ecosistema Marino del Golfo de México (GoM), busca contribuir a la detección de temas que requieren fortalecimiento y construcción de capacidades para abordar problemas ambientales; tal es el caso de los ecosistemas de manglar, los cuales son uno de los ecosistemas más amenazados y deteriorados en el GoM. El proyecto piloto de restauración ecológica se ubica en los manglares de Isla del Carmen, Campeche; y está basado en cinco líneas estratégicas: a) diagnostico ambiental, b) definición de acciones de restauración, c) organización para la ejecución de las acciones, d) Monitoreo de indicadores de éxito y e) Educación ambiental, capacitación y transferencia de experiencias. Hasta el momento se cuenta con un sitio piloto de restauración de manglares en el estero bahamitas de Laguna de Términos, con la participación de 80 personas de la comunidad ejidal de Isla Aguada. El programa piloto de restauración de manglares pretende forjar una experiencia de restauración desde su planeación, ejecución y evaluación del éxito para que posterior a ello pueda ser replicado en otros sitios degradados del Golfo de México.

Propagación de dos especies arbóreas ribereñas que sirven de alimento a una especie en peligro de extinción en la Reserva de la Biosfera Pantanos de Centla, México

Zamora Cornelio, Luis Felipe; Claudia E. ZenitenoRuiz, Ángel Sol Sánchez, Martha M. Torres Álvarez
El Colegio de la Frontera Sur

La vegetación ribereña en el río Grijalva en Tabasco, México se encuentra amenazada por procesos de cambios de uso del suelo ribereño y representa para la fauna zonas críticas de transición entre la zona terrestre y acuática. En el marco del proyecto “Estados de Conservación del hábitat de la tortuga blanca”, se realizó una investigación para identificar áreas en mejor estado de conservación del hábitat, identificar sitios con presencia de poblaciones y dentro de este trabajo se tuvo como objetivo identificar especies alimentarias para la tortuga blanca (Dermatemys mawii), una especie en peligro de extinción. Se realizaron recorridos de campo para ubicar fragmentos ribereños de vegetación y se realizó el registro del registro del de especies arbóreas presentes realizando la identificación taxonómica correspondiente. Se realizaron entrevistas a productores para identificar el alimento natural que consume la tortuga blanca y en los fragmentos de vegetación ribereña se identificaron las especies que forman parte de la dieta de la tortuga blanca. Se registró un total de 28 especies arbóreas presentes en dichos sitios de muestreo y de ellas se identificaron a Inga vera y Annona glabra como las principales especies consumidas; estas especies se propagaron en viveiro obteniendo un 95 y 86 % de germinación, respectivamente. El conocimiento de las especies que forman parte de la dieta de especies amenazadas es prioritario para la promoción de su propagación y mejoramiento del hábitat mediante su inclusión en el medio natural.

Morfología de plántulas de cinco especies nativas con potencial para la restauración de humedales en la cuenca baja del Grijalva-Usumacinta, Tabasco, México

Zamora Cornelio, Luis Felipe; Susana Ochoa Gaona, Georgina Vargas Simón, Jorge Castellanos Albores
El Colegio de la Frontera Sur

Gran parte del conocimiento sobre la morfología de plántulas es poco visible poco valorado por el sector forestal. Algunos estudios demuestran que los pequeños detalles taxonómicos son de suma importancia para la identificación de especies, particularmente cuando se desea estudiar temas como regeneración, sucesión natural o posibles parentescos filogenéticos. Se realizó la descripción y caracterización morfológica de plántulas con potencial para la restauración de humedales, toda vez que existe desconocimiento de los rasgos y características de algunas especies...
Geomorphic and habitats reconstruction at the restoration plan of the ‘Los Quebraderos de la Serrana Quarry’ (Toledo, Spain)


Universidad Complutense de Madrid

Mining, an essential activity for our wellbeing, is one of the human activities that causes a deep transformation of ecosystems, because it affects all of its components. The restoration of these areas allows the recovery of new landforms and ecosystems in the whole transformed land. The geomorphological reconstruction of areas affected by extractive activities is the most critical aspect of mining restorations, because it affects other key factors of restored ecosystems, such as the development of vegetation and soils, or the habitats structure, among others. The restoration plan of the ‘Los Quebraderos de La Serrana’ quarry (Toledo, Spain) includes a design of a geomorphological reconstruction by using the GeoFluvTM method and Natural Regrade software, based on principles of fluvial geomorphology to design stable landforms. This method allows getting: long-term stability of restored areas, increased visual appeal, reduction or elimination of maintenance and restored landforms which support functional and self-sustaining ecosystems, which replicate those of the surroundings. Because the location of the proposed project of the quarry ‘Los Quebraderos de La Serrana’ has been classified as an area of importance and distribution of the Spanish Imperial Eagle, the restoration plan has focused in mimicking the existing mosaic of habitats in the surrounding lands. This mosaic seeks to promote the establishment of stable and successful populations of rabbits, in order to provide prey to the Spanish Imperial Eagle populations.

Ecological restoration needs in oil/gas fields of Northern Patagonia, Argentina

Zuleta, Gustavo; P. Tchilinguirian, J.S. Fuchs, A. Bustamante Leiva, C. Navarro

Maimónides University

In the Monte Austral ecoregion of Northern Patagonia (semiarid steppes), construction of wells and linear infrastructure (roads, pipelines, seismic lines) accounts for more than 100,000 ha of medium-severe degradation that requires partial or complete restoration. Since first legal enforcement in 1992, and given recent (2011) updates (Neuquén Province), companies are compelled to recover pre-disturbance/exploitation conditions. Under this scenario, we reviewed restoration requirements and technical feasibilities to improve land planning and decision making. Representative study cases (practical management; scientific research) were examined over a 15-year period (1996-2011). Two major restoration approaches (passive and active) encompass most management needs, whereas feasibility of each technique/case primarily depends upon six individual factors: well density, cattle density, landscape attributes, ecological integrity, sediment accumulation, and erosion, as well as their interactions. Passive restoration (sensu lato) includes protection of natural areas with high conservation values, sustainable cattle raising (sites with low well density), natural regeneration monitoring (isolated well locations abandoned at least 15 years ago), closure of roads, and special management procedures (very high density of productive wells). Active restoration methods were classified in low and high-tech. Low-tech includes soil decompaction, soil/moisture amendments, and/or nebkhas/mounds regeneration (branching) in order to facilitate natural processes. High-tech rehabilitation approaches, with high costs and risks associated, also involves addition of nursery perennial plants and other germplasm (seeds mainly) of non-domesticated species, fertilization, and/or water supply. We also discuss how combinations of techniques apply for specific cases, further research needs, and legal gaps in the ecological restoration context.
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