THE WORLD CONFERENCE ON ECOLOGICAL RESTORATION

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Society for Ecological Restoration International

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Preface

This volume contains abstracts accepted for presentation at the 2005 World Conference on Ecological Restoration. They have been distributed in different sessions according to the appropriate conference program and the author's specifications, as much as possible. The Conference Program includes global, landscape, ecosystem, habitat, population, social, economic, urban, damaged and contaminated sites, and technical aspects of environmental restoration, as well as symposia proposed and arranged by participants.

Abstracts are arranged alphabetically in three groups (plenary, oral, and poster presentations) to facilitate organization. Texts have not been edited to respect original documents The name of each presenter is underlined. There is an author index at the end of the volume.

Thanks are extended to the Local Organizing Committee, the Scientific Committee, and to SER International staff for help in evaluating the abstracts and planning the conference program. If there are questions or requirements related to this volume and scientific aspects of the conference, we remain at your disposition.

Francisco A. Comín Mercedes García

Chairman Coordinator
2005 World Conference on Ecological Restoration

Tabla de contenidos

PLENARY SESSIONS

The Alexander River Restoration Project as a Bridge Between Israelis and Palestinians

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History is replete with examples of wars and conflicts related to water and rivers. The Alexander River Restoration Project, is a recent example of how a cross-border river can be an opportunity for cooperation between people who are in conflict, rather than the reason for the conflict. The Alexander River flows from the Palestinian city of Nablus, through Vadi Zaymar, up to the estuary of the Mediterranean Sea in Israel. It crosses under the separation wall in a large pipe, next to the Palestinian city of Tul Karem. The Alexander River Restoration Project, launched in Israel in 1995, is a comprehensive, interdisciplinary environmental project. The restored parts of the river, the ground water that both sides use for drinking, and the people who live on both sides of the wall suffered from the raw sewage which caused severe environmental and health problems. Since 1996 the brave local Palestinian and Israeli leaders from Tul Karem and Emek Hefer and their professional teams, have been cooperating on this environmental project. Two agreements, unique in nature, were signed, a joint plan was prepared, and with the assistance and mediation of the German government, works have been carried out to reduce the pollution. The rehabilitation of the sewage treatment ponds of Tul Karem was completed, and solved part of the severe environmental problems the people of Tul Karem face. Large scale plans remain for the coming years. The remaining question is: Can this unique cooperation between Israelis and Palestinians, which survived even during the most difficult times, be an example for a better future in the Middle East and elsewhere?

Keywords: River restoration, joint environmental project, cross-border river, environmental cooperation, environmental conflicts, Alexander River.

The Value of a Restored Earth and its contribution to a sustainable and desirable future

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The environment is not a luxury good. The services provided by intact and functioning ecosystems contribute to human welfare and survival in innumerable ways, both directly and indirectly. These services, and the natural capital stocks that produce them, have been depleted and degraded by human actions to the point that the sustainability of the system is threatened. This paper discusses the dynamics and value of the world's ecosystem services and natural capital from 1900 to 2000 and in two hypothetical futures: (1) a "business as usual" scenario and a "restored earth" scenario. The business as usual scenario assumes continued degradation of the earth's natural capital, both by conversion to urban and achardt andy prince Joanne Woytek George R. Rumney, II Serry Simpson The Ferraro y Lori L. Winter jmiller Beverly Floyd prof. Sergio Vetrella Dr. Comp In addition the RE scenario assumes changes in management of the remaining agricultural, urban, and heavily managed natural systems to an adaptive management regime that is focused on maximizing ecosystem services while also enhancing agricultural productivity and urban quality of life. The social benefit-cost ratio of investing in a restored earth is estimated to be at least 100 to 1, and probably much higher. The RE scenario is also shown to provide a significantly higher sustainable quality of life than the BU scenario. Some paths to achieving the RE scenario are briefly discussed.

Spatial ecological solutions at different scales to mesh nature and people in urban changing regions so they both thrive. With examples from Barcelona to Boston and the world

Richard T. T. Forman

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Today's spreading city represents for civilization one of the great challenges of history. A concentrated population depends daily and fundamentally on natural resources either far away or in the surrounding urban region, which is the possible path of future expansion. The focus here is on highlighting spatial patterns in the urban region so that both natural systems and their human uses thrive long term.

Common urban growth models are briefly evaluated from this perspective. Then a worldwide set of urban regions, differing in the arrangement of built and natural-resource area, is similarly evaluated. A land mosaic for the Greater Barcelona Region is presented as a case study. This highlights (a) an emerald network for nature, (b) diverse food areas, (c) a wide range of water-related issues, and (d) a wide range of development, industry, transportation and municipality issues. Land-use solutions that have wide applicability are emphasized.

The other major focus for long-term success is the town or municipality within the urban region. Several approaches and case studies are briefly compared. A land mosaic for a town in the outer suburbs of Boston is presented as a case study. This highlights (a) a promising approach to think and act regionally, (b) a large-patch and major-corridor network for nature and agriculture, (c) an objective method to compare and rank highly diverse small special sites, and a 25+ year record of active land protection for nature and people.

To most people the urban region is beyond comprehension and its future defies optimism. Yet outlining a spatially focused vision where both nature and people thrive long term is doable. The urban region as a whole, the town or municipality within it, and natural systems with their human uses are keys to a better future.

Ecosystem Degradation and Restoration in the Western China

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Western China covers 12 provinces with an area of about 6600 thousand squire kilometers accounting for about 68.8.3% territory of the whole country. The geomorphology patterns are unique constituting high mountains and deep river valleys, plateaus, and large basins. It can be divided into zones from middle temperate zone to peripheral tropical zone according to the latitudinal temperature gradient with additional two vertical zones of plateau temperate and sub-frigid zones. According to the humidity conditions, it varies from extreme arid to humid regions. Therefore, the natural ecosystem types are diverse along horizontal and vertical gradients. The latitudinal pattern of ecosystems from the south to north is tropical rain forest, sub-tropical evergreen broad-leaf forest, temperate grassland, and temperate desert. Along the longitudinal direction from the east to west, there is temperate forest, temperate grassland, desert grassland, and desert. Arid valley shrub land, evergreen broad-leaf forest, deciduous broad-leaf forest, sub-alpine coniferous forest, sub-alpine shrub, sub-alpine grassland, sub-alpine meadow, and alpine sparse vegetated ecosystem distribute vertically along the elevation gradient of high mountains. There are 7 out of the 11 terrestrial biodiversity hotspots in western China. However, owing to the impacts of global environmental change, local environmental fragility, and high population and development pressures, many environmental problems have emerged as soil and water loss, desertification, ecological degradation of grasslands and forests, the shrinking of wetlands, soil saltification and alkalinization, and the loss of biodiversity. The natural driving factors of these problems are the extreme climatic conditions and the unique geomorphological conditions. The human factors include the rapid increase of population, the irrational reclamation of natural ecosystems, the uncontrolled use of water resources, over grazing, over cutting, poor land management, the unconsciousness of the environment, and the ignorance of the environmental laws. It is an urgent need to restore the degraded ecosystems under the national western development strategies. Multidisciplinary cooperation and multi-stakeholder participation are indispensable for this restoration campaign. The principles of the restoration include: 1) eco-regional and even site specific and problem oriented restoration; 2) natural succession based restoration; 3) multi-objective and multi-measure restoration; 4) scientific and comprehensive planning based restoration; and 5) participation driven restoration. The success of the ecological restoration initiative in the western China depends on the establishment of a rational ecosystem management framework, which necessitate the enhancement of scientific research on the issues pertinent to ecological restoration.

Landscape Restoration in Some Tropical Biodiversity Hotspots

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Many of the world's tropical biodiversity hotspots are also regions subject to extensive degradation. The degree of degradation has increased substantially in recent years. This has been caused by a variety of factors including agricultural clearing, uncontrolled logging, fuelwood collection and fires. However, a common underlying driver of degradation is rural poverty. This raises the dilemma of whether it is better to try to conserve the remaining biodiversity in these landscapes or, instead, to give priority to overcoming poverty. In theory restoration might seem to offer a chance of achieving both aims. But this can be difficult because trade-offs are involved. The "traditional" approaches to overcoming degradation and improving livelihoods include intensifying agriculture and reforesting with fast-growing exotic species. Such approaches can improve livelihoods in the short-term benefits but do little to conserve biodiversity and there is evidence that they may lower both ecological and economic resilience over the longer term. On the other hand, approaches that simply aim to restore the original ecosystems are equally unsuitable since they usually provide no improvement to human livelihoods within an appropriate time frame. There are some site-level interventions that represent a compromise between these two extremes. However, it is likely that trade-offs and compromises may be more easily achieved at a landscape scale. In the case of forested landscapes, key biophysical elements of the landscape mosaic that will affect the way restoration is approached include the amount of forest remaining, the degree of fragmentation and the amounts of secondary or regrowth forest that are present. These will influence how much reforestation might be needed to achieve certain biodiversity or functional outcomes and where this should be carried out. The key socio-economic factors that will affect the way restoration is approached will include land ownership patterns and tenure, farm size and farmer income (or degree of poverty), markets for forest goods and services and the range of other competing land uses a farmer might adopt. These will determine the attractiveness of reforestation, the type of reforestation that might be adopted and the rate at which it occurs. Restoration often occurs across landscapes in an unplanned *ad hoc* manner. The disadvantage of this is that each landholder makes a site-level decision based largely on local knowledge and without reference to the broader landscape or to what other landholders are or may be doing. Most cannot afford to undertake activities that restore biodiversity. Planned forest restoration at a landscape scale should provide an opportunity to improve conservation gains and increase overall livelihood benefits. Conservation theory does offer some directions for planning ways of fostering the recovery of biodiversity across landscape. However, the key dilemma is in devising means of integrating this with the aspirations and objectives of a variety of stakeholders who may differ in economic and political power as well as in their degree of dependency on the outcomes of the decisions made. I will discuss some of these issues as well as the constraints and opportunities for undertaking forest landscape restoration using several tropical examples.

Conservation, restoration and creation of wetlands: A global perspective

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Wetlands, rivers, and watersheds are being created restored around the world, often in urban areas or arid climates. There are major disadvantages of urban wetlands that include the difficulty to accommodate nature in areas where many humans are present, the perception that wetlands harbor threats to human health and comfort, and the inability to modify hydrology without significant infrastructure. The disadvantages of wetland restoration in arid climates are the lack of sufficient water and salinity problems. These disadvantages are balanced with the potential values that these wetlands potentially have to large populations. In arid climates, wetlands can be the very essence of sustaining life and culture. Wetland values accrue when there is a human population to receive those values. In that sense, wetland and watershed restoration could actually be more valuable in urban and arid settings than in humid non-urban regions where they are found in more abundance. Examples of urban wetland restoration in the USA and arid wetland restoration and conservation in the Mesopotamian Marshlands in Iraq and Okavengo Delta in Botswana will be presented.

Land use and bioenergy options: relevance for reducing net GHG emissions, meeting Kyoto targets, and restoring ecosystems

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Land use, land-use change and forestry (LULUCF) plays a multiple role with respect to the global carbon cycle. Firstly, land use is a significant source of emissions of greenhouse gases (GHGs), mainly from deforestation and degradation of forests and other ecosystems. Secondly, climate change affects ecosystem in different ways, depending on ecosystem, relative change of temperature and precipitation, and other factors. Thirdly, by protecting existing ecosystems from destruction, or enhancing carbon stocks in terrestrial ecosystems, such as through afforestation and reforestation, the increase of GHGs in the atmosphere can be slowed. And fourthly, the use of renewable biomass for energy generation and as a raw material for wood-based products can provide an important, indirect benefit to the atmosphere to the extent GHG emissions from energy systems, and energy intensive products, can be reduced. This presentation will provide an overview of how LULUCF activities are included in the Kyoto Protocol, what this means for the reporting needs of countries as part of their national GHG inventories, what experiences have been made so far under the Clean Development Mechanism (CDM), how biomass energy can help to meet Kyoto Protocol targets, and why the largest LULUCF emissions source – deforestation – is not yet being covered under the Protocol. There are three key differences between land-based carbon sequestration, and other means of reducing GHG emissions (such as energy efficiency or renewable energy): saturation, permanence, and the large areas involved in LULUCF (as opposed to point sources in energy systems). Also, methods for monitoring and estimating GHGs in land use are different than those for projects to reduce energy-related emissions. The presentation will give a brief introduction into national-level and project-level methodologies for monitoring carbon stock changes in the relevant carbon pools (especially biomass, dead wood, litter and soils). In many situations there are trade-offs and/or synergies between maximized carbon sequestration, bioenergy use, and environmental restoration or protection of ecosystems. Numerical model results will be used to illustrate some policy recommendations on how to maximize GHG benefits while also supporting restoration objectives. The Kyoto Protocol is only a first step towards addressing the climate change problem. Its key benefit is that it puts in place systems to monitor, estimate, limit, and trade pollution permits, and provides a signal to the key players (including industry, transportation, agriculture and others) that the environmental costs of emitting GHGs are now internalized and/or national policies to reduce emissions will be put in place. As we move into negotiations for a post-2012 climate agreement, i.e. the Kyoto Protocol expires, it will be important to enhance engagement of some key developing countries, e.g., by widening the inclusion of LULUCF in these countries, and particularly by addressing emissions from deforestation. Two countries have already made proposals how this could be done (Brazil and Papua New Guinea), and this will briefly be summarized in the presentation.

Carbon Exchange by Terrestrial Ecosystems and their feedbacks with the Climate System

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The current sink of carbon is a delicate balance between uptake of oceans and terrestrial biota and emissions from anthropogenic activities and land use changes.

There are however no scientific evidences that such a sink strength will continue with the same magnitude and direction in the future. Across the globe there is great temporal and spatial variability in the rates and cumulated carbon exchanges by biomes due to temporal and spatial gradients in climate, available resources, plant structure and function, land use and soil development. Human activities, through modification of landscape patterns and socio – economic changes are also important driving forces of carbon uptake and release of terrestrial ecosystems. In this paper we address geographic variations in climate and vegetation affect net carbon exchange of terrestrial ecosystems and how likely climate changes could affect such processes. A mechanistic interpretation is provided by decomposing net ecosystem productivity (*NEP*) into its constituent componentsægross primary productivity and ecosystem respiration.

ORAL PRESENTATIONS

Towards a more safe environment: (4) Disposability of uranium by some clay sediments in Egypt

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Due to the increase concerns about the environmental pollution problems, it is so important in waste disposal management to perform an accurate exploration of geological barriers, which must be suitable for waste materials disposal. Clay sediments play an important role as natural adsorbents to immobilize heavy and nuclear metals contaminants.For the present study, the clay samples were collected from either clay exploitation localities or from nearby radioactive mineralization in Egypt. Obtained results indicated that uranium adsorption and desorption differ importantly in accordance with the source of clay sediment used. In addition, its adsorption increases by increasing uranium initial concentration. The obtained data were found to fit of Langmuir equation isotherms. Adsorption maxima (B) for uranium were high for Abu Tartur bentonite followed by El Hafafit vermiculite and was the least for Kalabsha kaolinite. However, the binding energy (b) that affects the adsorption process can be arranged in the opposite direction. Desorption of uranium by HCl, NaOH and tap water show clear ability of the different sediments to release uranium. This was a function of leaching solution and binding energy. Finally, the changes in the clay sediments through adsorption and desorption processes were investigated in detailed by I.R spectroscopy.

Keywords: adsorption-desorption, clay sediments, I.R, nuclear, pollution, uranium.

Mycorrhiza: a tool for forest restoration in calcareous soils

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Toxicity of calcareous soils is well established. This lead to the existence of large stripped and damaged areas. In this study we suggest to use mycorrhizal seedlings inoculated with suitable calcicole strains of mycorrhizal fungi in reforestation programs for calcareous soils. The mycorrhizal symbioses are mutualistic associations between plants and fungi. It has been unequivocally demonstrated that these associations confer many benefits to the plant and allow their establishment under many unfavourable ecological conditions. *Eucalyptus camaldulensis*, a calcifuge species, growing in a patch of calcareous soil in the north of Algeria was examined for mycorrhizal status. Results revealed that all the trees were mycorrhizal. Samples of this soil, containing the mycorrhizal fungus symbionts, were taken down to a depth of 25 cm. around the trees and pooled together. Then, it was divided into 2 parts and one of them was sterilized to eliminate all the soil inoculum. Seedlings belonging to 3 calcifuge *Eucalyptus* species were germinated in sterilized peat-perlite mixture (60-40 v/v). After two months of growth, they were transferred into pots filled with soil sterilized or not. All the seedlings transferred into sterilized soil grew very poorly, showed leaf clorosis or died. Seedlings transferred into non sterilized soil grew well. Observation of their root systems revealed typical mycorrhiza, arbuscular mycorrhiza and ectomycorrhiza. It is obvious that the fungi which formed these mycorrhiza are calcicole strains, allowing seedlings of calcifuge *Eucalyptus* species to establish in such a calcareous soil.The information generated by this study should enable the nursery man to target which mycorrhizal fungi to select as suitable inoculant for calcifuge species in such calcareous soils.

Keywords: Mycorrhiza. Reforestation. Calcareous soils. Calcifuge plant species.

Restoring Atlantic wet dune slack habitats in an artificial recharge area

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In an Atlantic coastal dune area the effects of changes in artificial recharge using river water (AR), groundwater discharge and management, on wet dune slacks, were studied at 12 locations differing in AR (stopped, unchanged, increased). Most of these locations were sod cut and grazed, some were also mown. Plant species composition, groundwater levels, nutrients in standing crop, chemistry of topsoil and groundwater were monitored for several years. At locations where AR stopped, Cl^-, Na^+, SO_4^{2-} levels in the groundwater dropped and visa versa. At locations with increased AR locally thin rainwater bodies developed in the topsoil rising dissolution of calcium carbonates. At locations with increased and un-

changed AR basiphilous, mesotrophic plant species recovered when groundwater levels were high during summer. At slacks isolated from infiltration channels restoration failed because of low groundwater levels. Some locations with lime-poor, organic topsoil are acidifying due to suboptimal hydrological conditions and partly decreased AR. The pattern of standing crop N/P-ratios revealed that locations influenced by AR were mostly N-limited, whereas other locations were P-limited. Although the P-load of river water decreased since 1991 by extended pretreatment, P-availability in AR-effected areas is still high. It is concluded that threatened dune slack vegetation can be restored in AR-areas when affected slacks are mown and in superficially decalcified slacks natural hydrology is restored and organic rich topsoil is removed. In AR-affected areas detailed design and management of the recharge and discharge regimes are crucial.

Keywords: dune slack, artificial recharge, restoration, nutrient.

Forest structure and diversity as a tool for restoration systems assessment

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Methods for defining structural attributes of forest ecosystems must be based on quantitative indices that lead to objective analysis of human influences or natural succession processes. The indices for characterizing structure and diversity of ecosystems allow a better reproduction of forest conditions in a given moment and of its evolution in time. They also allow the evaluation of sites condition in which restoration systems were applied. Such indices would have to be considered in addition to conventional variables such as diameter, height and basal area, in order to achieve a better description of the restored sites. The objective of this paper is the compilation of diverse quantitative variables to describe structural attributes from the arboreal stratum of the ecosystem, as well as different methods of inventory to obtain such indices, namely by sampling nearest neighbour information. These variables and attributes can be used to characterize modifications of diversity and structure resulting from restoration practices and to measure differences between ecosystems in time and space. For the evaluation of the species structure and diversity the indexes of Shannon *H'*, Species Profile *A*, Segregation *S* of Pielou and the Species Mingling index *Mi* are discussed. The Aggregation index *R* of Clark & Evans and the Contagion index *Wi*, were include in order to describe the horizontal structure of the ecosystem. Finally, for the characterization of the dimensional structure, the Homogeneity Coefficient *H*, and the indexes of Diameter Differentiation *TDi*, Height Differentiation *THi* and the tree attribute Dominance of Neighbours *Ui* were analyzed.

Keywords: diversity, mingling, differentiation, restoration, Mexico.

Restoration of disturbed aquatic ecosystem by artificial vegetation island (AVI) in oligo -meso trophic Lake Paro, Korea

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After cut off of inflowing water from North Korea from 2001, the littoral zone of Lake Paro, an oligo - mesotrophic lake was perfectly diminished. Without the littoral zone, the fish community was disrupted. For restoration of littoral zone, a system with macrophytes on floating medium, called artificial vegetation island (AVI) was installed at the bay area. But the concentration of nutrients in lake water was not sufficient for plant growth. For overcoming this problem, medium which is suitable for bacterial attachment, bacterial growth and spreading roots of macrophytes was developed. In this medium, by the bacterial aggregation, the TN and TP were highly concentrated as 489 mg/l and 5 mg/l respectively. After launching 1,800 m^2 of AVI in Lake Paro, the macrophytes, Iris (*Iris ensata*), Yellow iris (*Iris pseudoacorus*) and Reed (*Phragmites communis*) were well growing on that medium. Under the AVI, fishes were using the roots of macrophytes as spawning and hiding place and on the AVI, ducks were using the AVI as relaxing area and using the stem and leave of macrophytes as food. This solar energy based and self designed AVI can be used as alternative method for restoration of disturbed littoral zone.

Keywords: artificial vegetation island, macrophyte growth, lake restoration, littoral zone.

Implications of rural-urban migration for forest restoration in Latin America

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Rural-urban migration is one of the most important current demographic processes, in particular, in countries undergoing socioeconomic changes associated with globalization. In most regions, the lands that are being abandoned are in the mountains, in areas with steep slopes. These areas play a major role in determining watershed regimes including floods and the seasonality of water flow. The increase in vegetation cover by natural regeneration or restoration will help reduce erosion and floods, and at the same time provide habitat for many organisms. Given that demographic and socioeconomic changes appear to be as important as conservation efforts, we need to make a stronger effort to understand and incorporate these processes into forest management and conservation activities.

Keywords: natural regeneration, abandoned agricultural lands, montane forest.

Impact of long term application of wastewater on soil microbial biomass C and N and accumulation of bacteria of fecal origin

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In most countries of the Mediterranean region such as Jordan, there is an increasing and an urgent need to conserve and protect water resources. Water is a vital resource but a severely limited one in these countries. Consequently, the reuse of wastewater for agriculture is highly encouraged. The objectives of this study were to evaluate the cycling of C and N within the system through the determination of microbial biomass C and N and the health hazard that may associated with the using and handling of wastewater. Soil samples were taken from different sites from the Ramtha wastewater treatment plant. Sites that have been irrigated with wastewater for the last 17, 10, 4, and 1 years were identified and used as the sampling sites for this study. In addition, another two sites that have not been irrigated with wastewater were sampled as a control. From each location, soil samples were taken from several sites within each location, and at the following depths: 0-20, 20-40, and 20-60 cm. Microbial biomass was determined using chloroform fumigation technique and found to increase with increasing period of wastewater application. Results showed that microbial biomass as C was a lot higher than the microbial biomass as N. The bacteriological analysis showed that the total aerobic bacterial count of surface soil (0-20 cm) were higher in sites irrigated with wastewater for the last 10 and 17 years, suggesting that the use of this wastewater stimulate these microflora.The total coliforms ranged from $0.92x10^2$ CFU/g to $17.0x10^2$ CFU/g, while fecal coliform were less and only detected in sites irrigated with wastewater for the last 10 and 17 years.

Keywords: Wastewater. Biomass. Coliforms.

What is Forest Landscape Restoration? Some experiences and lessons learned from WWF's global portfolio of initiatives

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In response to the challenges of the continuing loss of forest cover and quality, with associated development as well as environmental problems in many parts of the world, WWF, working in collaboration with IUCN and other partners, has adopted a "Forest Landscape Restoration" approach, which is defined as "*a process that aims to regain ecological integrity and enhance human wellbeing in deforested or degraded forest landscapes*". The concept of FLR is not a new idea. It builds on a number of existing rural development, conservation and natural resources management principles and approaches, bringing them together to restore multiple forest functions to degraded landscapes. WWF's Forests for Life Programme is actively developing a learning portfolio of FLR initiatives in a number of countries and regions including the Mediterranean, East Africa and Madagascar, Atlantic Forests of Argentina and Brazil, New Caledonia, China and Indonesia. Although most of these initiatives are relatively young in terms of a restoration timescale, a number of interesting and useful lessons and experiences are starting to emerge related to planning, development and implementation. These include the need for a full and representative multi-stakeholder planning process, clear goals – both biodiversity and socio-economic and simple tools for tracking changes at the landscape level. Further aspects of work which warrant more focus include the role of FLR in carbon sequestration within the Clean Development Mechanism, and as a tool for engaging

with Governments and the private sector to improve the multiple functions of forests in and around plantation holdings.

Keywords: forest, landscape,WWF.

New handbook on forest restoration in landscapes, and an update on the global partnership on forest landscape restoration

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In response to multiple requests for guidance, WWF has developed this book on how best to approach the restoration of forest functions in landscapes. The book is a compilation of short chapters, bringing together the expertise of over 60 specialists and practitioners. It offers simple, practical advice and examples from around the world, covering both temperate and tropical forests and is intended to outline current knowledge and examples, while highlighting outstanding gaps. The topics cover different stages in the restoration process, from planning through to negotiation and to specific restoration techniques that have proven effective or are currently being tested. Along with concise, practical information the handbook gives many suggestions for further research. Based on the experience of compiling this guide and the key lessons identified it also presents some ideas on an emerging decision-making framework to help guide implementation.The Global Partnership on Forest Landscape Restoration was launched in March 2003 by IUCN, WWF, and the UK Forestry Commission. It is a network of governments, organisations, communities and individuals who recognise the importance of forest landscape restoration and want to be part of a co-ordinated global effort. Main activities of the Partnership include: building momentum for restoration with decision-makers, the private sector, public and media. Facilitating partnerships and networking. Analysing experiences, highlighting opportunities, identifying obstacles and disseminating lessons learnt. Stimulating public and private investment in forest landscape restoration.

Keywords: handbook, restoration, temperate and tropical forests.

Long-term ecological monitoring and restoration of Piñon-Juniper wodlands at Bandelier National Monument, New Mexico, USA

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Woodlands of piñon (*Pinus edulis*) and one-seed juniper (*Juniperus monosperma*) at Bandelier National Monument in northern New Mexico (USA) exhibit greatly accelerated rates of soil erosion, triggered by historic land use practices (livestock grazing and fire suppression). This erosion is degrading these woodland ecosystems and damaging thousands of archaeological sites in this national park unit. Researchers and land managers have teamed up to study erosion patterns and processes, and to experiment with restoration techniques. Restoration experiments and detailed monitoring of vegetation cover, tree growth patterns, and hydrological processes began during an unusually wet climatic period in the early 1990s. Severe drought conditions emerged in the late 1990s through 2003, resulting in major ecological changes in these woodland ecosystems, including massive dieback of dominant woody and herbaceous plants. Our long-term monitoring also showed hydrological changes in runoff and erosion patterns. Our primary restoration treatment (thinning and application of slash mulch) was demonstrated to be an effective remediation technique for increasing herbaceous cover, stabilizing soils, and supporting surface fire. Monitoring shows that the restoration treatment also increases the resiliency of vegetation to drought effects. Long-term monitoring is essential to distinguish short-term variability from longer term trends, particularly in highly dynamic ecosystems. The value of long-term ecological monitoring data is enhanced through linkages to larger networks, allowing local contributions to even global change-scaled issues.

Keywords: long-term monitoring, woodland restoration, erosion, drought effects.

Ecological restoration under a changing environment: atmospheric nitrogen deposition and biological invasions

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Southern California shrublands are subject to anthropogenic N deposition, primarily from automobile emissions, with levels up to 30 kg N ha^{-1} yr^{-1}. In addition, coastal sage scrub has been invaded by an understory of Mediterranean annual grasses that increases flammability, promoting an increased frequency of fire. Observations along an urban-to-rural N deposition gradient showed a loss of diversity of native forb species from 67 to 16 species per ha, and an increase in exotic grass cover from 1% to 70%. Long-term N fertilizer studies in a site with low N deposition confirmed the relationship between elevated soil N and decline of native vegetation; after 10 years of N fertilization the native species began to decline in abundance even without fire, with a concomitant increase in exotic grass cover. Restored stands of native shrublands typically have an understory of exotic grasses, but these are comparable to local undisturbed stands that also have weedy understories. However, both restored and natural stands are intrinsically unstable because of their susceptibility to fire when grass biomass is high in soils with high N. Restoration of the diverse native forb component will be even more difficult to achieve, and will require a reduction in soil N. Ultimately the solution will be to strengthen air pollution legislation to reduce N emissions. The time required for soils with elevated N to decline to natural background levels is currently unknown, but will be required before restoration can be carried out successfully.

Keywords: exotic annual grasses, Mediterranean ecosystems, nitrogen deposition, stability.

Flow requirements as a tool for restoring brown trout population dynamics in regulated streams

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Changes on stream flow regimes due to the function of small hydroelectric dams (known as “minihydros”) are usually observed in mountain streams. These changes concern not only the intensity of flow but also the variability and frequency of high and low-flow episodes. Former studies have showed the influence of flow variability on the dynamics of a resident brown trout population, especially that related to the stream flow regime during spawning, incubation and emerging periods. As these stages are known to determine the population dynamics in further ages, stream flow variability appears to be a mayor factor on the regulation of a wild brown trout population. Thus, mean flow discharge should not be the only parameter taken into account when establishing ecological flow regimes in order to re-establish proper flow conditions for the enhancement of altered trout populations in mountain streams. Setting ecological stream flow regime characteristics, in base to conclusions obtained in a former study (Alonso-González *et al.*, 2004), is propounded as a tool for the restoration of degraded trout populations inhabiting mountain reaches downstream hydroelectric devices. Case studies were conducted in a high mountain basin in Central Spain (River Tormes) during 5 years showing that relationship between duration and frequency of high low-flow episodes during egg incubation could be linked to young of the year recruitment and quantified in terms of flow management units. Duration and frequency of flow discharges can be set so as to reach desirable population levels in brown trout populations affected by hydropower flow regulation.

Keywords: Stream, flow regime, population restoration, brown trout.

Remediation of hydrocarbon contaminated soils in Mexico using vermicompost

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Contamination of soil with hydrocarbon occurs frequently in Mexico through oil spills. Restoration of these contaminated sites might take a long time through deficiency of nutrients (N, P) for the petroleum degrading micro-organisms thereby increasing a possible impact on the ecosystem. Waste water treatment is increasing throughout Mexico generating large amounts of biosolids that are often incinerated because they contain pathogens thereby loosing a valuable source of nutrients (N, P, and K) and organic material. Vermicomposting or composting with earthworms reduces amounts of pathogens while maintaining nutrient levels. Addition of vermicompost to hydrocarbon-contaminated soil might accelerate their degradation so soil was amended with vermicompost and spiked with three different polyaromatic

hydrocarbons (PAHs: phenanthrene, anthracene, benzo(a)pyrene). The same amounts of PAHs and vermicompost were also added to soil and sterilized to study the effect of abiotic factors. Dynamics of PAHs, C and N were monitored for 100 days in an aerobic incubation experiment. Application of organic material did not affect the concentration of phenanthrene and anthracene, which decreased sharply in the first weeks of the incubation. Less than 3% of the added phenanthrene was detected after 100 days and less than 8.5% of the added anthracene. The decrease in concentration of benzo(a)pyrene was not fast as that of phenathrene and anthracene, and 22% was extractable from soil still after 100 days. It was concluded that addition vermicompost only had a transient effect on removal of phenanthrene, anthracene and benzo(a)pyrene in soil of Acolman, while abiotic factors had no significant effect.

Keywords: remediation, contaminated soils, monitoring.

Assessing complex vs. simple restoration strategies in damaged Great Lakes-St. Lawrence Forest, Canada

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Assessing the community-level consequences of ecological restoration is essential to guide future restoration efforts. We compared the structure of the vegetation at sites that received a range of restoration treatments (from simple one-dimensional treatments involving abiotic enhancements to complex, multistage revegetation treatments using native and non-native species) and a series of naturally recovering sites. Canonical correspondence analysis and cluster analysis was used to determine which restoration treatments explained differences in the community structure among sites. We found that native understory vascular plant species richness is restored by more complex restoration treatments; however, the role of planted trees and non-native species in these artificial community assemblages remains unclear. Understory vascular seeding played a key role in determining community composition of vascular understory and overstory communities, but the time since restoration commenced was a more important factor for non-vascular communities since they received no direct biotic enhancements. The use of non-native species in the vascular seed mix seems to be slowly encouraging the colonization of native species, but non-natives continue to dominate restored sites 25 years after restoration began.

Keywords: restoration treatments, native, non-native species.

Restoration of Skjern river and its valley

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A monitoring programme was set up to evaluate the ecological effects of a restoration of 19 km of the Skjern River and river valley. The 22 km^2 project area was reclaimed for agricultural cultivation in the 1960s by channelizing the river and pumping water into the river. The restoration in 1999-2002 included re-establishment of a meandering river and the natural water levels and floodings. The monitoring showed immediate increases in numbers and species of both breeding and migratory waterbirds. Breeding waterbirds increased rapidly from 6-8 to 34-36 species, and 105 species of migratory birds were registered. Within two years the vegetation of the former cultivated fields changed from weeds typical for cultivated fields to species typical for natural wetlands. After two years the vegetation was still under rapid development. The plant coverage in the new river course was reduced but the numbers of species increased on the new river banks. The river invertebrate community was a clean river fauna both before and after the restoration, but the invertebrate densities increased because of increased occurrence of gravel in the riverbed. There was a minor increase in the death rates of trout and salmon smolts because of predation by birds and possibly pikes. The retention of nitrogen and phosphorus in the project area was less than 10% of the total nutrient transport through the river.

Keywords: river, valley, restoration, vegetation, birds, fish, invertebrates.

The Community-Owned Forest of Arcata, California: A Model of Sustainable Redwood Forest Restoration

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The Arcata Community Forest established in 1955, comprises 803 hectares of 100-120 year old second growth redwood forest in Humboldt County California. Community Forests are relatively rare in the western United States, but recently there has been an increasing interest and effort to establish community forests in many areas. The City of Arcata government leaders and its citizen's are committed to a sustainable management program that serves as a model of a managed redwood forest for demonstration and educational purposes. Timber harvest revenue funds forest operations and open space and parkland acquisitions. During the past 25 years, various silvicultural systems including variable retention, group selection, group selection with green tree retention and single-tree selection has attempted to mimic natural disturbance regimes such as wind throw and low intensity fire. The goal of providing habitat for species associated with late-successional forest habitat in second growth redwood forests has primarily focused on retaining structural elements while creating multi-aged stands, increased species diversity and introducing "chaos" into relatively even aged 120-year-old stands. An array of permanent plots is used to monitor changes in understory vegetation, structural features such as logs and snags, invasive species, lichens, bryophytes and liverworts. Plot data is compared to reference stands including small adjacent patches as well as larger old growth forest areas in nearby Redwood National Park. Arcata's adaptive management approach to increase biodiversity, accelerate old forest conditions, provide late successional forest habitat while providing revenue is a long-term project that provides a valuable case study for the region as efforts to restore redwood forests are expanded.

Keywords: Redwood, sustainability, restoration, community forestry.

The effect of Acacia saligna and dune stabilization on rodent populations in Ashdod-Nitzanim sands

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The coastal dune habitat of Israel is diminishing rapidly, mostly due to massive urbanization, fragmentation and changes of habitat characteristics caused by dune stabilization and the introduction of *Acacia saligna*, an invasive species brought to Israel for the purpose of dune stabilization. We studied the effect of sand stabilization, on the populations of small mammals. The research was conducted from April 2003 through April 2004 in the Ashdod-Nizzanim sands; it included a total of 58 trapping nights. We analyzed differences in species diversity, abundance and body condition of each species of rodent in four plots: Unstablized dunes, semi-stablized dunes, stablized dunes and one plot with the presence of *Acacia saligna*. *Gerbillus pyramidum* and *Jaculus jaculus* were captured almost entirely on the unstabilized dunes. Gerbillus andersoni allenbyi was captured mostly on the semi-stabilized plot. On the other hand, human commensals such as *Mus musculus* were found only on the stabilized dunes and on the Acacia plot. Cluster analysis of species similarity among the four plots places the very similar stabilized and semi-stabilized plots in the same cluster with the Acacia plot wheras the unstabilized plot forms another, distinct cluster. The results of this research show that dune stabilization is followed by changes in rodents populations - the disappearance of psammophile rodents and the appearance of human commensals. Measures should be taken to stop the spread of the Acacia and the continuing stabilization of the sands in order to conserve the psammophile species.

Keywords: dune stabilization, *Acacia saligna,* rodents.

Restoration of a closed-off estuary in the Netherlands, consequences for biogeochemistry and terrestrial vegetation: first results of a mesocosm experiment

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In 1970 the Haringvliet, the largest estuary of the Netherlands, was closed-off from the North Sea; the water became fresh and the tidal influence decreased. Recently, plans have arisen to restore part of the lost wetlands by partly re-opening the Haringvliet dam. This will have significant effects on both vegetation and soil processes, due to increased dynamics in redox values by tidal fluctuation and increase in salinity. We designed a mesocosm experiment with sods from two former tidal marshes in the Haringvliet area, with and without a history of agricultural land-use. The experiment consisted of a full-factorial design with increased salinity and tidal amplitude. During the two-year experiment plant species composition, plant nutrient content, soil pore water, soil processes and the community structure of sulphate reducing bacteria were monitored.After one year a distinct effect of brackish water on the vegetation was visible; standing biomass was reduced considerably, but no effect of tide on biomass was detected. In all treatments plant-available nitrate in the soil decreased, and ammonium values increased. Denitrification rates decreased but remained higher in non-tidal treatments. In all treatments soil iron oxides were reduced, resulting in the mobilisation of iron and phosphates. In the non-tidal treatments mobilisation of iron was highest, indicating a lower redox potential in the non-tidal situation. A further analysis of the results of year one and a continuation of the experiment for another year should provide information necessary to elucidate the effects of increased salinity and tide on biogeochemical processes and terrestrial vegetation.

Keywords: Estuary, restoration, soil processes, salinity, vegetation composition.

The Phytochemistry of the Medicinal liverwort, *Riccia nigerica* Jones

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The phytochemical composition of the African liverwort, *Riccia nigerica* Jones has been studied. Extracts were obtained from fresh plants of *Riccia nigerica*. Fractions were obtained through column chromatography. The absorbance spectra of the five fractions of the extracts varied from 0 to 1.18 at 400 to 950 wavelenght. The anti-microbial activities of the crude extracts were tested against some selected species of bacteria and fungi.The test extract was found to have significant inhibitory effect (>17mm zone of inhibition) on plated colonies of *Bacillus substilis*, *Pseudomonas aeruginosa*, *Staphylococus aureus*, *Shigella dysenterae*, *Aspergillus flavus* and *Rhizopus sp.*.The results of the phytochemical study outlined in this work has shown that the extract of *Riccia nigerica* exhibited a remarkable inhibitory effect on test organisms both bacteria and fungi.It can be infered that *Riccia nigerica* could be a cheap source of antibiotics. Expectations are high as regards the future development and the possible application of the extract as a source of medicinal drugs.

Keywords: *Riccia nigerica*, inhibitory effect on test organisms.

Reference systems and evaluation

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While acknowledging the conceptual arguments brought by some ecologists against the use of reference systems, we argue that the exercise of constructing an explicit reference system is highly useful for the planning, orientation and evaluation of short-term restoration interventions and long-term, multidimensional conservation, management and restoration. We shall present arguments in favor of using reference systems, from one or many sources of information, illustrated with case studies from tropical and extratropical forests, and from Mediterranean woodlands and their derivatives embedded in cultural landscapes of venerable age. In light of the growing number of *emerging ecosystems* and the paradigm of managing socio-ecological ecosystems *from the inside out*, the notion of restoring to the past must, however, be definitively replaced with that of *restoring* to the future. Thus the use of historical references inevitably requires careful reflection and nuance.

Keywords: Reference systems, restoring to the future.

Lanscape restoration of marginal olive groves in Andalusia

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Due to the reform of the olive oil MCO some olive groves in mountain areas will become non-productive. The abandonment of these cultivated lands will have an effect on several landscape sustainability criteria: biodiversity, soil erosion, fire hazard and visual quality of the rural scene. The first phase of this three years research project has been to devise a marginality index for olive cultivation based on soil quality and slope. According to this index, we estimate an area over 200,000 hectares of marginal olive plantations in Andalusia. Some corrective measures in the area of study, the mountain areas of the province of Cordoba, are explored to minimize the negative impact of this abandonment, being the use of grass cover in the olive plantation, the connection of olive groves with natural protected areas via green corridors and the integration of buildings through vegetation the most positive.

Keywords: land abandonment, olive groves, biodiversity, soil erosion, fire hazard and visual quality.

Effects of restoring oak savannas on tree water uptake dynamics in the tallgrass prairie region of the Midwest, USA

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Conversion of native savanna and prairie ecosystems to annual cropping systems in the Midwestern U.S. has dramatically altered hydrologic functioning, leading to increased runoff, soil erosion and nutrient loss. One approach to reversing this trend is restoration of native ecosystems. However, little is known about the effects of restoration on plant-water dynamics. This study examined changes in individual tree and stand scale water uptake in encroached and restored savanna ecosystems. Sapflow was measured using thermal dissipation probes for 3 *Quercus macrocarpa* and 4 *Ulmus americana* trees in an encroached savanna and 3 *Q. macrocarpa* trees in a restored savanna. Mean total daily transpiration for trees was 3 - 4.8-fold lower for *U. americana* compared to *Q. macrocarpa*, while sapflow among oak trees did not differ significantly. In contrast, sapflow velocity was significantly greater for elm trees compared to oak trees, likely a result of their young age and vigorous growth. On an ecosystem scale, estimated total amounts of water transpired were more than 7-fold greater in the encroached savanna relative to the restored savanna. These results suggest that oak trees in these restored savanna ecosystems are not moisture limited. Since forests may sustain much greater total water uptake, savanna restorations may not be desirable if a central management goal is to reduce runoff. Further research is needed on water uptake capacities of the herbaceous understory and effects of tree-grass interactions on resource partitioning, runoff, and infiltration dynamics in restored savannas to better understand changes in hydrologic functioning following savanna restorations.

Keywords: tallgrass oak savanna, restoration, sapflow, transpiration, plant-water cycling.

Ecological diversity and productivity of the baobab (*Adansonia digitata*) in Benin

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This study was carried out in the Sudanian (9°45' - 12° N), Sudano-Guinean (7°30' - 9°45' N) and Guinean (6°25' - 7°30' N) zones of Benin. The objective of this study is to evaluate the ecological diversity in Benin of *A. digitata* populations across the climatic gradient, and to quantify the average productivity of its pulp, seeds, kernel. The distribution and relative abundance of the baobab was studied by means of megatransects and by surveying a number of selected sites. In each zone, an estimate was made of pulp, seeds and kernel production from 1200 fruits harvested from 30 individuals. In the Sudanian zone and in some regions of the Dahomey-Gap in the Guinean zone, a population density of 5 baobabs was recorded per km^2. In the Guinean zone, a density of only 1 baobab per km^2 was recorded. The baobab population's occurred on sandy soils in the Sudanian and Guinean zones and on sandy–clayey soils in the Sudano-Guinean zone. Flowering and fruiting of the baobab is seasonal. The morphology and productivity of the individuals' baobabs varied significantly from one zone to another. The zones with high values of Potential Evaporation, rainfall, relative humidity, temperature, pHwater and percentage of fine silt are associated with a low seed and fruit pulp production. The higher the pH_{kcl}, the percentage of total nitrogen, organic carbon and organic matter, the higher the number of seeds produced by an individual

baobab. The higher the clay and crude silt content of the soil, the better the productivity. The high values of C/N ratio and rainfall, are negatively associated with biotic characteristic of baobab. Much more scientific work is needed to elucidate patterns of genetic diversity in relation to distribution, ecology and morphological variability found in the baobab tree.

Keywords: Baobab tree, ecological diversity, organs production assessment, climatic zones, Benin.

Urban stream restoration in the municipality of Madrid

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The progressive dissapearence and degradation of the natural drainage network of Madrid municipality is revised, according to the intensive urbanization process carried out during the last decades. A siginificant number of urban and peri-urban streams still remain, constituing an important natural and historical heritage worthy to be preserved. The Madrid City Council has developed since 1996 a stream conservation policy that introduces innovative and more environmental friendly solutions than those adopted in the past. The implemented measures and the general criteria for management are presented, with field examples of restoration works carried out in the Meaques, Antequina, Valdebebas and Pozuelo streams, together with present projects for restoration and daylighting of other historic watercouses in Madrid municipality.

Keywords: streams conservation policy, Madrid, field examples.

Restoring large-scale functional lake-fringe and floodplain wetlands at the Williamson River Delta, Oregon, USA

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The Williamson River Delta in south-central Oregon, USA, is a 3000-hectare wetland-floodplain system formed where the Williamson River enters Upper Klamath Lake. The delta is critical refugia for threatened and endangered fish, and provides important habitat for a large number of migratory water birds. Historically an extensive wetland, the entire delta was diked and drained for agriculture, eliminating much of the wetland, riparian and lake-fringe vegetation community. The Nature Conservancy, working with federal, tribal and private partners, is implementing a program to restore the naturally functioning delta-wetland system. With a lead grant from the National Fish and Wildlife Foundation, a design plan for the complete restoration of the delta has been developed using information on the distribution and habitat needs of larval and juvenile suckers, hydrologic requirements of native wetland vegetation, and nutrient processes in the lake and wetlands. A hydraulic model of the delta was developed to identify and design levee breaches and potential riverine restoration options, as well as to evaluate the geomorphic and hydraulic effects of proposed restoration alternatives. Restoration elements include: breaching lakeshore and river levees to reconnect the property to the surrounding water bodies; grading the remaining levees to create diverse habitat features; reconnecting an historic oxbow channel to the main river channel and recreating multiple channels at the river mouth. The Conservancy has completed three pilot restoration projects that include breaching levees to reestablish the historic hydrologic connection between the delta wetlands and the lake and river. Thousands of larval and juvenile suckers are now using these newly created wetlands.

Keywords: wetlands, floodplain, fish habitat, restoration, riverine, modeling.

In Our Own Hands: The Story of Wildlands Restoration volunteers

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Wildlands Restoration Volunteers, Colorado, USA

Wildlands Restoration Volunteers (WRV), Colorado, USA, restores ecologically damaged areas by building community, fostering agency and business relationships, and teaching restoration skills. WRV accomplishes important restoration work that would not be possible within budget constraints of public land managers. Funding comes from grants and agency funding and from private donations of money, food, and equipment. Projects include: weed pulls, forest road obliteration, wetland and streambank restoration, salvage of tundra sod, fire restoration, wilderness trail reroutes, and native seed collection. WRV Partners

include U.S. Forest Service, U.S. Fish and Wildlife Service, U.S. Geologic Survey, Rocky Mountain National Park, local Open Space Departments, and recreation clubs. Restoration design professionals, graphic designer, backhoe operator, and tree thinning service offer discounted services. WRV seeks participation from diverse groups; four wheel drive clubs helped restore habitats extremely eroded by off road vehicle use. Not just for people who can move boulders, stake erosion control matting, and rake seeds – volunteers participate in fund raising, project design, web site maintenance (http://www.wlrv.org/), cooking for crews, and providing campfire music. Project duration ranges from an evening of seed gathering to a day on site to a camping weekend. WRV's program of volunteer restoration projects works because the projects are fun and highly social, use a variety of skills, are located in beautiful settings, and build empowerment to care for the land. By the end of the 5th season, volunteers had completed 65 projects and donated 37,000 hours to improve ecosystems as WRV seeks to put restoration "In Our Own Hands."

Keywords: restoration, volunteers, public lands, empowerment.

Ecological restoration of coral limestone quarries on the Kenian coast

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The restoration of a cement factory's coral limestone quarries on the Kenyan coast, started in 1971. Approx.100ha of former quarries has been restored to date into a mosaic of indigenous coastal forest ecosystems, lakes, wetlands and grasslands. Another 100ha are in various stages of restoration, with the area increasing as mining continues. Initially *Casuarina equisetifolia* is planted as pioneer species to colonize the open quarry, and over the years create humus from leaf litter and a suitable microclimate for other plant species to grow. Over the past 15 years more than 400 coastal plant species have been introduced into the mature *Casuarina* plantations. While the main aim is to create diversity, special emphasis is laid on timber trees and conservation of threatened species. To create grassland the original topsoil is brought back, and grass planted. Herds of domesticated eland and *oryx* antelopes speed up the grassland development as they deposit seeds and nutrients with their droppings when they come to drink from the quarry ponds. Lakes and wetlands are created by excavating into the ground water, and linked into a system of lakes, ponds and wetlands. A demonstration fish-farm has been established, and it's pumping activity drives the water circulation. Hippopotamus and other wildlife have been introduced and are the main attraction for the visitors to the quarry nature trails - tourism is the main revenue generating activity in the rehabilitated quarries, besides forestry and aquaculture.

Keywords: Restoration, diversity, former quarries, tourism.

Soil organic matter accumulation in restored New York wetlands

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Wetland restoration is increasingly used as a strategy both to address historic wetland losses and to mitigate new wetland impacts. Limited research has examined the success of restored wetlands in the eastern U.S. for avifaunal habitat, plant biodiversity and cover; however, less is known about soil development in these systems. Soil processes are particularly important as soil organic matter, texture, and other properties are directly linked to wetland functions for water quality improvement. This research examined soil development processes in 30 restored wetlands in western New York. We compared soil properties and soil development processes of wetlands of three different ages, e.g. ~2, 10, and 30 years since restoration, but which were comparable in restoration methodology, soil type, landscape position, and hydrologic regime. Replicated soil cores from each site were analyzed for soil organic matter content, bulk density, texture, root abundance, and chemical properties. Aboveground plant biomass and litter were quantified as key soil contributors. Additionally, replicated litter bags were used to document and compare rates of litter decomposition. Results suggest that older restored wetlands had different rates of decomposition, amounts of soil organic matter content, and bulk density than did younger wetlands. All restored wetlands studied were low in organic matter content relative to natural counterparts. We conclude that thirty years after restoration, these wetlands do not provide the water quality functions of their natural counterparts.

Keywords: Wetlands, soil organic matter, soil development, water quality.

Direct seeding of native plants for revegetation of abandoned desert farmland

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Direct seeding methods to revegetate abandoned farmland were tested at a desert site west of Phoenix, Arizona, U.S.A. A selection of native seeds was broadcast onto plots prepared by mulching, imprinting, chiseling, and fertilizing with phosphorous in a complete block design. Each main plot was split into subplots that were not irrigated, irrigated, or irrigated with *Salsola iberica* weed removal by hand. Native seeds germinated poorly on all treatments. On the other hand, annual, non-native weeds, primarily *Brassica nigra*, *S. iberica*, and *Schismus spp.*, germinated and established in all plots. None of the soil treatments had a significant effect on seed germination or establishment. Near the end of the second growing season a seed bank study was conducted in the greenhouse. Undisturbed desert soil had relatively few weed seeds and more native plant seeds than the disturbed agricultural soil samples, which had few viable native seeds and were dominated by *Schismus spp.*, *B. nigra*, and *S. iberica*. The results illustrate the difficulty of establishing native plants in abandoned desert farmland, due to the dominance of weedy species, the presence of salts in the soil, and the lack of adequate soil moisture in the treatments without supplemental irrigation.

Keywords: revegetation, restoration, irrigation, desert agriculture, weeds.

Restoring the forest: microenvironment, stomatal conductance and survival of mulched native tree saplings in a tropical dry deciduous forest

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A study to evaluate microenvironment parameters (net radiation, Rn; air temperature and humidity, Ta and *VPD*, respectively; and soil temperature and humidity, Ts and SH, respectively), physiological parameters (stomatal conductance, g_s; height growth) and survival of three native mulched species (*Caesalpinia eriostachys, Lonchocarpus eriocarinalis and Ipomea wolcottiana*), were carried out in a highly perturbed area of a tropical dry deciduous forest in western Mexico. Soil was isolated with three mulch types: white plastic, straw and litter. Registered values of Rn, Ta, Ts were significantly lower in areas with mulch than those in bare soil, whilst humidity (air and soil) increased considerably with mulches. Additionally, it was found that the presence of plants also reduced Ta and increased the amount of water vapor, making *VPD* lower. Survival and height growth were higher after one year in *I. wolcottiana* plants followed by *C. eriostachys* both in plastic mulch. *L. eriocarinalis* showed the lowest values in survival and height growth in all treatments. Results leads to the conclusion that the use of mulches is recommendable in the restoration of perturbed areas of scarce rainfall since more water is retained in the soil. In general the extreme microclimate is mitigated, favoring conditions for an adequate stomatal function and plant survival.

Keywords: microclimate mitigation, native plants, reforestation, scarce precipitation.

Evaluation of plant damage by ungulate herbivores in reforestations

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More than a millennium of overexploitation in the Mediterranean basin has resulted in loss of most forested areas. In this situation, human intervention is needed to accelerate the recovery of woodlands, reforestation being the usual procedure. However, reforestation success is conditioned by several environmental and biotic conditions. For example, ungulate herbivory could decrease the growth rate of saplings, or even kill them. We determined ungulate damage in 18 reforestations carried out in three mountains of SE Spain, focusing on reforestations made with *Quercus ilex, Q. pyrenaica, Pinus nigra, P. sylvestris*, and/or *Acer opalus* subsp. *granatense* on different years. We quantified the proportion of plants damaged and estimated the percentage of buds eaten by ungulates. Herbivore damage varied between species, places and years. One-year-old reforestations showed little herbivory damage, whereas the older the reforestation was, the higher the herbivory damage. This increase in herbivore damage is directly related with plant height; however, the more palatable species had a higher damage probability even at small plant sizes, provoking a major delay in their growth. For pines, the least palatable species, ungulate damage probability was low the first years but dramatically rose when plants increased in height.

Herbivory tolerance of pines is small, so that herbivory damage a seriously affected their development despite the lower intensity. Our results reveal ungulate herbivory damage as an important factor to be taken into account as in reforestation planning.

Keywords: Reforestation, ungulate, herbivory, palatability.

Experience in Working out of a Program of Remediation and Development of Ural Old-Time Industrial Region

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A model of working out of a program for stable development of Ural areas of minerals mining and technological processing suffered real technogenic disasters is discussed. Approaches to this problem resolution were developed under two ISTC projects taking the city of Karabash, Chelyabinsk region, for example. The model orients on internal resources of the territory and includes the assessment of environmental, resource and technological priorities. Conclusion on first-priority measures for the population protection were made. Effect produced by the Karabash Industrial Area on the region environment was assessed. All wastes accumulated in Karabash (composition, properties and amounts) were fully investigated. Existing and innovative technologies for each type of waste treating were searched out and assessed. Some of them that can be used specifically for Karabash deposits were experimentally proved. A consistent set of technologies for waste handling and territory and public health remediation was defined.

Keywords: program, remediation, stable development, assessment, environmental, resource, technology, priorities.

How to preserve the biodiversity in agricultural landscapes?

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The agriculture intensification in the second half of the 20th century resulted in a dramatic decline of biodiversity in western Europe. However there are also large agricultural landscapes in Central- and Eastern European countries (CEE), especially in Hungary. The recent joining to the EU of CEE countries will probably re-structure agriculture there and will threaten the still relatively high biodiversity by increasing intensification of farmland management. Can agri-environmental programs balance the expected decline in biodiversity of the CEE countries if farming will be intensified? We studied this question by comparing birds, arthropods (orthopterans, bees, spiders, beetles and bugs) and plants of 42 extensively and intensively cattle grazed paired fields in three regions of Hungary (alkali steppes and meadows in Central Hungary and alkali steppes in Eastern Hungary). The pastures were paired; an extensively and an intensively grazed site formed the pair. We found more bird species on intensive pastures, which had more heterogeneous landscapes with farm buildings and shelters, while the number of individuals were higher in the extensive sites. We generally found more grasshoppers on the extensive sites, however in the Eastern Hungarian region there was an opposite, but not significant trend. It seems that the abundance of grasshoppers is determined by the local factors (vegetation, ground, litter cover, etc.) and by the landscape factors as well. The preliminary results of the other arthropod taxa indicate that intensively and extensively grazed sites had different assemblages, but this largely depends on the local vegetation structure.

Keywords: Agriculture intensification, cattle grazing, arthropods, birds, plants.

Native-species seeding and chopped-wood mulching as post-fire rehabilitation treatments in Mediterranean forests in SE Spain

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We assessed the effectiveness of new seeding and mulching rehabilitation treatments to mitigate soil degradation and enhance vegetation recovery. The treatments were designed to fit the principles of ecological restoration, using native species and forest materials, aimed not only at protecting the soil from erosion and degradation but also at enhancing ecosystem function and resilience. We tested seeding, mulch, seeding plus mulch, and control (untreated) treatments for field conditions under Mediterranean climate in southeastern Spain. The area was burned by a wildfire on November 2002. The experimental plots were set-up on three burned patches of young *Pinus halepensis* forest. Treatments were applied two weeks after fire on twelve 2.5 x 6 meters plots arranged following a randomized complete block design. Mulching material was chopped wood from nearby pine forests. The seeded mix included perennial grasses, herbs, sub-shrubs and tall shrub native species. Seeding plus mulch treatment significantly enhanced plant cover, and seeded species contributed to structural and functional recovery. However, neither seeding nor mulch alone influenced vegetation recovery. Mulch and seeding plus mulch treatments significantly reduced soil surface compaction and enhanced water infiltration. The mulch layer also greatly reduced post-fire soil loss. Seeding without mulching was not effective enough to protect the soil surface from degradation. At the very short-term, it can not be expected that either natural vegetation or seeded species provide enough soil protection. However a mulch layer, either with or without seeding, can effectively protect soil functions until vegetation regenerates or seeded species establish.

Keywords: Emergency seeding, mulch, soil conservation, post-fire restoration, wildfire.

A model-based approach to landscape design, meeting ecotoxicological and landscape-ecological criteria

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In the BERISP project (Breaking Ecotoxicological Restraints in Spatial Planning) we develop a decision support system (DSS) for use in an iterative and participative approach to ecological restoration of contaminated areas.Main steps in the process are spatially-explicit eco-toxicological risk assessment and landscape design. The DSS is expected to be useful by providing both an evaluation of risk for a specific area as well as simple guidelines (rules) to evolve the landscape towards a low-risk landscape, within constraints set by stakeholders and by the species' ecology. Ecological constraints may relate to the amount or configuration of high quality habitat for a target species, while other constraints may relate to, e.g., landscape characteristics determining recreational attractiveness. Risk assessment focuses on the expected daily uptake of contaminants like PCBs and cadmium, for top-predators like Little owl (*Athene noctua*) and hedgehog (*Erinaceus europaeus*). The underlying models estimate contaminant uptake for all components of a food-web, taking into account the typical spatial scale of each species (group) involved, in particular focusing on the spatial pattern of resource exploitation. For the two top-predator species, landscape-dependent foraging models will be developed and validated within the BERISP project. We will present the underlying models and some general insights already obtained, and discuss the framework, within which these models are applied, taking both theoretical landscapes as well as a specific Dutch floodplain area as examples.

Keywords: spatially-explicit risk assessment, landscape design, foraging models, food web, spatial scales.

Old growth redwood forest restoration: growth, structure and interim yields under variable retention management

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The potential of the variable retention silvicultural system as a tool for restoration of old growth coast redwood (*Sequoia sempervirens*) forests was examined. Field data were collected from Jackson Demonstration State Forest, Mendocino County, California and summarized to describe the growth and struc-

ture of 100-year old regenerating redwood stands managed under variable retention. Increment core data were used to reconstruct recent diameter growth rates, tree and stand volume growth. Tree height, live crown length, and branch-free trunk length data were used to describe vertical stand structure, and were depicted graphically, complemented by color slides of the regenerating stands. Leaf area index and stand density index were calculated and compared with data from old growth and regenerating stands. The growth and vigor of the new cohort initiated by the restorative harvest treatment was assessed in small subplots. The future growth of these trees, and other understory cohorts initiated by future harvest treatments was discussed with reference to estimates of future canopy tree growth, crown expansion, and growing space occupancy within the restored structure. Data collected within adjacent undisturbed redwood stands were used to derive indicative variable retention harvest yields. The average diameter, height and cubic volume of cut trees will inform managers interested in producing forest floor log debris or deriving returns from restorative variable retention harvest treatments. Once key structural elements and features of old-growth redwood stands have been defined, the data and results presented herein could guide future restoration efforts aimed at meeting defined structural goals for old-growth restoration.

Keywords: Old-growth, redwood, *Sequoia sempervirens*, restoration, variable retention.

Bio-geo-chemical Cycles and their practical implications in Management of Degraded Sites by Restoration Forestry

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One of the main objectives of 'Restoration Forestry' is to suggest the management options for improving degraded soil fertility through biological processes of trees. This aspect was formulated on the premise that the sustainable productivity of a natural ecosystem is derived to a great extent from the bio-geo-chemical processes of litter and soil. These processes include biomass and nutrient accumulation by carbon assimilation, nutrient recycling by litter fall, root turnover and their subsequent decomposition and decay resulting in humus synthesis. The soil fertility build up and its sustainability is dependent not only on the maintenance of these activities at certain critical levels but even more importantly on their functioning as an integrated system with regulatory mechanisms operating in a synchronized manner. Essentially it means making the acyclic processes more cyclic thereby leading to the improvement of structure and function of an ecosystem. Little, however, is known about the mechanism of these effects especially with respect to restoration of degraded sites by tree planting. The discussion in this paper is focused on these aspects of restoration forestry and their importance in field management based on bio-geo-chemical cycles of plantations raised for restoration of various categories of degraded sites such as saline, sodic, sand dunes, waterlogged and mined spoils. It is envisaged that a judicious decision on management of a restored area would depend on such rotations that maintain and sustain the cyclic nature of ecosystems without jeopardizing the production from such areas.

Keywords: Ecosystem degradation- Ecological rotation- Restoration forestry-Sustainability.

Biomass and nutrient accumulation in restoration plantations of an age sequence of *Prosopis juliflora* (Swartz) DC grown on degraded sodic soils in Haryana, India

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The objective of this study is to address the issue of sustainbilty of management options for *Prosopis juliflora* plantations raised on sodic soils in Haryana, India set up primarily for the purpose of soil reclamation. Sustainability, in the context of this study, is defined as the maintenance and/or enhancement of organic matter and nutrient build up in the soils, which is driven by carbon assimilation and photosynthesis in the living biomass and the return of organic matter to soil via litterfall and root turnover. The approach taken was to monitor these indicators of sustainabilty along a gradient of increasing tree biomass, detritus biomass and under-storey development and corresponding changes in soil organic matter and nutrient build up in a 0-, 5-, 7- and 30 year old chronosequence. The intention was to examine the sustainability of management recommendations in relation to temporal patterns of biomass and nutrient accumulation in an age sequence of *Prosopis juliflora*. Specific objectives were to: (1) examine nutrient budgets, nutrient cycling and growth partitioning in the age sequence, (2) to study dynamics of nutrient storage in soil and vegetation biomass over time, and (3) to examine the changes in understorey community structure in the *Prosopis* chronosequence.

Keywords: Sodic soils, Sustainability, Restoration, Chronosequence, Nutrient Budgets.

Habitat improvements on intensively cultivated Swiss farmland

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Agricultural land in Swiss Lowland is exploited intensively. This has a negative impact on agro-biodiversity: half of the bird species typically breeding on farmland, for example, are threatened. In 1990 we started restoration projects in four regions in south-western, northern, central and eastern Switzerland, respectively. These regions have a high potential for successfully restoring biodiversity, although they are at present farmed intensively. Each project was adapted to local conditions, including target species, improvement measures, types of applied ecological compensation areas (ECA) like wildflower strips, low-intensity meadows or hedgerows. Much effort was put into a close collaboration with farmers; ecologists and farmers decided in close co-operation on the location, type and management of ECA. Since 1993 all Swiss farmers have to cultivate on their land ECA's to get direct subsidies. However, the quality of these ECA's is often lower than the quality on the four restoration test regions. The close partnership between ecologists and farmers could have resulted in a higher quality of the ECAs in our test regions. The data of our four restoration projects demonstrate that target farmland bird populations have been increasing on arable land with 5-10 % ECAs of high quality. Where grasslands predominate, however, we could find no effect of ECAs on breeding bird populations. Nevertheless, if natural habitat elements such as ponds were created on such areas, both biodiversity and populations of amphibians and dragonflies increased.

Keywords: Arable farmland, ecological compensation areas, grassland, evaluation, birds, habitat improvements, biodiversity.

Application of molecular genetic markers in conservation and restoration of genetic resources of *Araucaria angustifolia* (Brazil)

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The objective of this study is to assess population level genetic structure and dynamics of the *Araucaria angustifolia* in remnant patches, with different levels of human modification and distributed within a typical landscape of southern Brazil. Theses data are being used to improve our understanding of the impact of fragmentation and to guide policies for habitat conservation and restoration. The Araucaria forest is one of the most important biomes occurring naturally in southern Brazil. The extensive logging and agricultural expansion of recent decades have resulted in significant fragmentation of the forest cover. Temporal analysis of Landsat satellite imagery (1977 and 2003) has shown that the plots studied were originally connected and that the landscape was a matrix of forest interspersed with patches of agricultural land. By 2003 the opposite was evident, with small patches of forest within a matrix of agricultural land. The genetic diversity is being assessed by the use of microsatellite markers. The molecular marker results have shown that the fragmentation of the forest could have contributed to the differentiation of the allelic and genotypic richness of the studied population. The survival of remnants of *Araucaria angustifolia* patches and as well single clumps in the agricultural landscape is key factors for species conservation and potential restoration.

Key words: Genetic diversity; microsatellites and conservation; conifers.

Ecological processes and plant characteristics controlling vegetation establishment on road slopes in semiarid Mediterranean environments

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This study aimed at determining the ecological processes or "filters" that limit vegetation colonisation on road slopes in a semiarid Mediterranean region and identifying plant functional traits or types that characterized the most successful colonising species. Different possible causes of low colonisation success were identified and analysed according to the type (roadfill vs roadcut) and aspect (North vs South) of the slopes. Vegetation surveys of the road slope vegetation and surrounding areas, sowing experiments on road slopes, germination experiments in water-stressed laboratory conditions and seed removal experiments under simulated rainfalls, were performed to determine the relative importance of seed dispersal, road slope conditions (environmental factors) and seed removal by runoff in road slope colonisation. Road slope conditions that control plant germination and development -especially soil water availability for plants- were more limiting for plant colonisation than the joined effect of seed dispersal and seed re-

moval by runoff. Several plant traits relative to seed, root and leaf characteristics were associated to plant colonisation success on road slopes. Knowledge about the filters controlling road slope colonisation and plant traits shared by successful species is a guarantee for road slope restoration.

Keywords: colonisation, seed dispersal, environmental factors, erosion, plant functional types, road slopes.

Public support for ecological restoration in Flanders (Belgium)

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In 2002 an interdisciplinary social-legal research project was carried out in four ecological restoration projects in Flanders, all situated on former intensively used agricultural land. Different standardised interviews and questionnaires were used to estimate the internal capacity (i.e. responses of members and co-workers of a nature NGO and the Flanders nature agency) on the one hand and the (lack of) external support for conservation and restoration measures on the other (including responses from adjacent inhabitants, day-trippers and farmers). A multi-actor analysis was done. In all cases, a large public support for nature reserves amongst people living in the neighbourhood and people using the area for recreation could be observed. The so-called NIMBY-syndrome (Not In My Back-Yard) could not be confirmed. However, knowledge on the nature reserve and particularly on the accessibility thereof, is an important factor in obtaining public support. There also exists a large conditional public support amongst all the categories of respondents for the transformation of agricultural land into nature areas. The most important condition that was mentioned by all the groups was cooperation with local farmers. There is less public support from farmers towards ecological restoration than support for classical nature management measures. An important element in the arguments obtained from the farmers is the different view on nature between farmers and environmentalists. The lack of knowledge on nature policy and nature legislation amongst farmers also leads to a lack of public support.

Keywords: ecological restoration, public support, multi-actor analysis, Flanders.

The Price of Ambition

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In 1999 substantial funding was obtained to undertake an extensive programme of scrub clearance from the Norfolk Broads in eastern England. Ground conditions are extremely soft and vulnerable, and the sites are often flooded. The project aimed not only to do the work, but also to develop new and effective ways of working in such difficult conditions and on a large scale. The chosen contractors spent a lot of time, money and effort trying to make 'the ideal system' work; but after four years the project was way behind schedule, and the contractors debts were huge. The standards and the costings were too ambitious. This talk looks at what went wrong, and the lessons to be learned; but has a warming finish, because at the eleventh hour a compromise on our ideals, permitting a change in systems, has allowed a dramatic acceleration of progress; a return to profitability for the contractor, and the project is now racing towards a dramatically successful conclusion.

Keywords: scrub, fen, mechanisation, Broads.

A Big Boy's Toys – 2005

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Ecological Restoration needs tools and equipment, and as the scale of restoration projects grows, so the equipment needs to keep pace. As standards of work improve, and targets for minimising collateral damage are raised, so better equipment must be developed. Alaska Environmental Contracting are well known at home in the UK and abroad for our innovation and adaption to meet these challenges. This presentation unashamedly relishes in the delights of the 'big toys' we are currently using for restoration. In 2001 it was the light railway extracting timber from wetland that excited people. This year we have, amongst other things, huge amphibious excavators, all-consuming air curtain incinerators, a paddle tug,

and to cap it all a 70 tonne hovercraft! As well as fun pictures, we will put this equipment into it's logistical context; examining options and approaches to the movement of materials, equipment and staff over sensitive terrain, and the ecological needs that spur on the development of such specialised solutions.

Keywords: mechanisation, specialised equipment, amphibious excavator, incinerator, paddle.

Ecological restoration of dry tropical forests in Mexico: a revision of the state of the art on propagation and reintroduction of native tree species in degraded lands

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Tropical deciduous forest (TDF) is the predominant tropical vegetation in Mexico. It once covered 14% of the territory, but high deforestation rates have caused forest loss, while the remaining forests are fragmented, altered (27%), or converted to degraded lands (23%). Therefore, restoration of vast areas is an urgent task. A review of the state of the art of knowledge on propagation methods and performance of species under different environmental conditions shows that it is still fragmentary and concentrated in a few species. Although throughout Mexican TDFs the more diverse and frequent plant families are Leguminosae, Euphorbiaceae, Burseraceae, Cactaceae and Compositae, propagation protocols show a large bias towards early succesional leguminous species. This is explained by their abundance, their frequent association with nitrogen-fixing bacteria, and the fact that many species are natural colonizers of disturbed sites. However, research on a wider spectrum of species is urgently needed, particularly on genera comprising tree species dominating undisturbed forests, namely Bursera, Ceiba, Cordia, Lonchocarpus, Jatropha and many others. This should also include research on conditions conducive to high seedling establishment and growth, as existing evidence points to high mortality during the first years after seedling reintroduction, as a result of water stress and a sharp increase in predation from small mammals when other resources are unavailable. Restoration will also benefit from studies on succession in TDFs, a subject only recently addressed. It is expected that the establishment of the first Station for Environmental Restoration in the Morelos state will gather research on a variety of subjects that are crucial for restoration of TDFs.

Keywords: Tropical Deciduous Forest, Mexico, plant propagation, reintroduction, succession.

An industrial research chair or how peatland scientists and peat industry can benefit from each others

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Research in peatland restoration began around 1992 in Canada through a partnership of scientific researchers from different universities (Peatland Ecology Research Group), the Canadian peat moss industry and governmental agencies. At that time, the common objective was the integrated sustainable management of Canadian peatlands. More than ten years later, research in peatland restoration has progressed immensely, both in the areas of applied and fundamental science. The vision of the peat industry has also evolved and regulations on peat mining have also been created in some provinces. Although no models for a Decision Support System (DSS) or other model have been specifically developed for peatland management, many tools have been used to transfer and communicate scientific results to peatland managers and land users. Scientific workshops are organised annually to present the latest results. Newsletters (*Echo tourbières*) are largely distributed to inform industrial partners and other collaborators of current research activities. Moreover, annual technological transfer workshops allow scientists to teach some useful information and restoration methods to peat industry employees, who in turn bring their practical expertise to the field of improving application of restoration methods. For example, the large-scale restoration of the Bois-des-Bel experimental field station (Quebec) has been successfully achieved by the combined efforts of scientists and peatland land users. Working in collaboration with many competing peat companies has represented a major challenge for the scientists. However, the opportunity to join various forces and expertises allows us to make more progress in resolving problems in the field and applying results of scientific projects.

Keywords: peatland, restoration, technological transfer, communication.

Restoration and development of degraded lands in arid and semi-arid areas - examples and conclusions from Israel and Africa

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Degradation of lands and natural resources in arid and semi-arid areas is a major global challenge. The main reasons for degradation are frequently similar. These can include population growth, nonsustainable use and overexploitation of natural resources (overgrazing, deforestation, use of salinated water, etc.), growing use of water, contamination of water or soil, impact of global changes, and human ambition either to survive (in low income areas) or to use more and more of the resources (in all areas). These problems are frequently the cause of social or economic crisis, or are related to them. Many differences can also be found between areas: natural resources, climate, social and economic situation, technological level, political atmosphere, culture, landscape, and more. Unfortunately there are no prescriptions, no miracles and no "one-dimensional" solutions. It is important to have a good understanding of the problems and processes and to prepare a comprehensive multidisciplinary plan based on site-specific analysis. The solutions will always reflect a delicate balance and combination of physical, economic, social, environmental, management, educational and other aspects. Public participation, capacity building, budget, belief and patience are also often essential for success. There are many examples of tools which can be used for the restoration and development of degraded lands in arid and semi-arid areas: a) develop new water resources, b) more efficient use of water, c) remove specific problems and restore degraded land, d) develop new types of agriculture and techniques, e) develop non-agricultural sources of income, f) develop new infrastructure and political leadership

Keywords: Degradation, arid and semi-arid areas, tools for the restoration.

Qualitative Reasoning Models for Building Understanding of Aquatic Ecosystem Ecological Restoration

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In the framework of a project funded by the European Commission, an innovative technique from artificial intelligence - Qualitative Reasoning- is used to investigate alternative ecological restoration scenarios in degraded aquatic ecosystems. Our approach involves developing qualitative reasoning models of five aquatic ecosystems that focus on a variety of environmental problems: 1) eutrophication and water pollution processes, indicated through aquatic community composition in the Danube Delta Biosphere Reserve, Romania; 2) effects of organic pollution and other urban and industrial pollution on abiotic and biotic structures, River Mesta, Bulgaria; 3) biological populations and communities, biodiversity, habitats, and ecosystem interactions within the Riacho Fundo, Brazil; 4) driving forces of underlying river restoration actions in Austria; 5) different degrees of water quality, flow regulation and habitat degradation problems in the River Trent and Yorkshire River Ouse, England. QR models developed by ecologists will describe each system both to learn about their specific restoration system, and to develop a deep understanding about cause and effect processes in the environment, to support practical decision-making.

Keywords: Qualitative reasoning, aquatic ecosystem ecological restoration.

Restoring coastal turf communities in Taranaki, New Zealand

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Distinctive indigenous turfs, typically less than 15 millimetres in height, grow on the margins of coastal terraces in areas that are exposed to strong salt laden winds, such as, headlands and coastal indentations. These communities are dominated either by the endemic grass *Zoysia minima* (Poaceae) or the herb *Selliera radicans* (Goodeniaceae) and support nine species officially classified as rare or endangered. Removal of the adjacent natural sequence of vegetation has put these fragile communities under threat of

displacement by introduced pasture species. A method for the translocating and establishing new coastal turf communities was trialed between April 2003 and June 2005. Three sizes of turf plugs (25, 50 and 80 mm^2) were translocated from an intact community to a coastal margin bare of vegetation. Transplanted cores were randomly distributed at either 5 or 10 percent cover in 42 plots of 500 mm^2, two distances parallel from the terrace margin. For each of the plug sizes average cover was either stable or declining in the first year following the translocation. In the second year there has been an increase in cover of the two larger plug sizes irrespective of initial percentage cover. Associated miniature herbs have maintained survival with *Colobanthus muelleri* (Caryophyllaceae) colonising up to 11 metres from the site of translocation. Bare terraces can be re-vegetated using translocation of short-stature turf communities which will have positive implications for the survival of these threatened plant communities and coastal terrace erosion.

Keywords: Indigenous, Coastal, Turf, Translocation, Terrace.

Using grazing exclusion, stones cover restoration and plant neighbour removal to restore two native perennial plants to degraded steppe in South-eastern France

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La Crau (south-eastern France) is a steppe dominated by *Brachypodium retusum* and *Thymus vulgaris*, that has evolved with both edaphic and climatic aridity and centuries of itinerant sheep grazing. This site of a great biological value has been degraded by human activities (cultivation). The steppe vegetation resilience being extremely low, ecological restoration was attempted by improving environmental conditions and by re-introducing some perennial dominant steppe species (*Thymus* and *Brachypodium*). Germination being low on the abandoned fields, target species were transplanted in a factorial experiment to test three treatments: grazed/ungrazed, restored stone cover/disturbed stone cover, neighbor removal/neighbor intact. The effect of high nutrients, remaining in the soil as a result of fertiliser application during cultivation, was tested by carrying out the experiment on three plots with a fertility gradient. The ideal combination of treatments included: 1) the exclusion of sheep grazing the first year to optimize establishment; 2) neighbor removal which increased seedling growth; 3) restored stone cover to protect seedlings from rabbit grazing and summer drought. The fields with higher fertility levels had lower plant survival but much greater growth. In order to re-introduce target species to degraded steppe patches, we recommend transplanting seedlings and applying the three treatments as described above.

Keywords: abandoned field, competition, dry grassland, facilitation.

Ecological restoration – offering nature our assistance

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Through ecological restoration, we offer nature our assistance to repair or recover degraded or destroyed ecosystems and environments. However, nature does not always respond to our assistance in a manner that we had hoped, ergo the number of so-called 'failed' restoration projects. Similarly, our celebrated 'successes' show that the assistance we have provided is consistent with a response or pathway that nature may have intended to follow unassisted. Thus, nature filters our restoration actions and effectively 'decides' those that are most suitable for restoring a given site. Restoration management often involves significant manipulation of abiotic and biotic variables and usually contributes a range of additional trophic interactions to a system. There has been little research undertaken to explore the extent to which our 'assistance' impacts upon or adds to the extant ecological processes operating within a restoration site. With extensive interference of all ecosystem variables, it is difficult to develop any general models to predict the outcomes of restoration action. The ad-hoc methods employed in restoration practice confound this problem further.Current restoration paradigms assume that an ecological model is appropriate to test in a restoration context. This presentation argues that pure ecological models are inappropriate as direct reference for the development of conceptual restoration theory and further, fall short of delivering adequate guidance for restoration management practice. Progression in restoration ecology will depend upon developing and testing conceptual models that incorporate the input of our 'assistance'. Ini-

tially, we need to overcome the ideology that our interaction with nature is simply assisting or facilitating the recovery of natural processes. Our restoration management adds to extant natural processes and thus, we inadvertently become an additional player in the system structure. Restoration models need to recognise the trophic roles of our participation in the natural system and the ecological consequences of our management actions on the other biotic and abiotic components. To this end, we may develop more accurate conceptual models and gain insight for improved ecological restoration practice.

Keywords: Ecological restoration, ecology, people, assistance, interaction.

Challenges and prospects for sustainable development and restoration in arid and semiarid areas.

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More than half of the earth's land surface is defined as arid and semi-arid, yet, their share in the global population and political power and economics is much smaller. Arid and semi-arid landscapes pose particular challenges as well as prospects for sustainable development and restoration. These areas share some common characteristics such as limited resources (e.g., water and productive soil) and high spatial and temporal variability in resources and conditions. While many of the characteristics can be individually found in other areas, their co-occurrence in arid and semi-arid areas can be defined to be unique. The recognition of the differences between arid and semi-arid landscapes is important for sustainable development. Sustainable development and restoration means wise use of resources for the benefit of present and future generations. Wise use also implies making the best use of existing local resources rather than wasting resources in efforts for large scale landscape transformations. The survival of healthy human communities in these areas depends also on preventing the rise in global temperature. Knowledge and understanding of the specific characteristics in these areas and adapting appropriate policies to enhance prospects rather than expensive landscape transformation efforts are critical. The challenge for sustainable development should also include empowering local communities, respect and protect their traditional ways of life and ensure their participation in the development. The differences between arid and semi-arid landscapes, the need for careful adaptations of policies and technologies as well as economic and cultural processes to the ecological processes, will be the focus of this paper.

Keywords: arid and semi-arid areas, sustainable development, policies.

Multiple scale assessment for planning the ecological restoration of the Middle Ebro floodplains

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The ecological restoration of ecosystems can be planned at different spatial scales depending on objectives and facilities for implementation. Small scales can be useful for patch or reach approaches. Assessment at large scale is necessary for planning restoration at large scale. A multiple scale assessment can be useful for planning the ecological restoration at large scale while providing the ecological requirements for efficient restoration at smaller scales. A landscape scale assessment of land-use changes of the Middle Ebro floodplain was done from comparison of aerial photographs different decades during the second half of the XXth century. Lack of longitudinal and transversal continuity of natural ecosystems is a common fact in all the floodplain. Also, accelerated silting of ox-bow lakes and loss of connectivity are observed. These changes are related with intensive use of the flood plain for agricultural purposes, establishment of dikes at the river shores, decrease of average river water flow and disrupted water regime of the river. Disrupted patterns of spatial plant distribution were observed in spectral transects of plant diversity measured in three different parts (proximal, central and distal) of different groves of the floodplain, and were related to human intervention (poplar plantations for wood production, controlled grazing by farm animals, and gravel extractions). Light extinction through the air column in woods and soil organic matter show differences at patch scale related to the physical structure of the woods and to the use of the soil for different purposes, respectively. Results from this multiple scale approach can be assembled to plan restoration at different spatial and temporal scales. In order to set up plans and goals for ecological restoration at large floodplain scale, water river flow and regime are key factors to be considered as increasing water connectivity is an essential characteristic to be recovered for efficient restoration at large scale. At grove scale, increasing connectivity and/or controlled plating, together physical design

could be efficient actions to recover processes driving to restore ecosystem heterogeneity and diversity, including ox-box lake turnover.

Key words: floodplain, landscape, grove, patch, scales, assessment, restoration, planning.

On the use of microbial bioremediation to reduce organic matter pollution in riverbed sediments of the Jucar River Basin (Spain)

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Strong organic matter pollution of sediments of aquatic ecosystems difficults water quality recovery, which in turn is of paramount relevance in the restoration of polluted rivers. An experimental study was conducted in some Mediterranean streams from East Spain to evaluate the suitability of microbial bioremediation for the *in situ* reduction of organic content of sediments in polluted riverbeds. Lyophilised microorganisms and ectoenzymes were inoculated in summer in the sediments and the evolution of the organic matter content was monitored. Control areas of untreated sediments were also established. Satisfactory results in the reduction of organic matter (up to 60 % within two months) were found in sediments previously showing high organic content (around 30 %), especially those with higher biodegradability, such as those found in riverbeds that historically received domestic sewage inflows. On the opposite, in sediments with organic matter content lower than 8-10 %, variations were not substantially different that those observed in non-treated control areas. Similarly, sediments containing high amounts of C-rich N&P-poor organic matter (e.g. cellulose) were not substantially recovered by the bioremediation treatment. As a result of this study, microbial bioremediation techniques will be selectively considered for some future restoration activities in streams of the Júcar River Basin Authority.

Keywords: microbial bioremediation, river sediments, organic matter reduction.

Integrative restoration in the semi-arid Tehuacán-Cuicatlán Valley, México: ecology and local community involvement

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Successful ecological restoration depends on negotiation and understanding of different stakeholders, including the daily users of the resources, government institutions that will regulate resource use and the research community working in the area. One of the options for restoration is to select species that have multiple functions in a system ("multipurpose species"). Plant species may impact the system in several unexplored ways and serve more purposes than just improving forage or soil fertility or acting as windbreak. Our aim was to identify plant species that could be used for the Valley restoration (part of it a biosphere reserve since 1998) in keeping with needs of natural resources management, biodiversity conservation and local culture. We propose that the genus *Mimosa* (Leguminosae) holds the best candidate multipurpose species due to the prevalence of the plants in the Valley, endemism, preferences of local people and large number of potential functions in the ecosystem. We found that four species (*M. lacerate*, *M. luisana*, *M. polyantha* and *M. texana*) had important environmental attributes: they play a nurse role, create symbiotic propagule-rich sites, and function as resource islands. Their physical structure provides shade and acts as a windbreak, counteracting erosion and improving micro-environmental conditions that can facilitate the establishment of other species and harboring insects, birds and rodents. Management of the biosphere reserve and Valley needs to be open, evolving and adaptive, requiring the integration of local communities and alternatives to foster economic and human development that are socio-culturally and ecologically sustainable.

Keywords: Plant, multipurpose species, improving environmental conditions.

Heidegger and the Paradox of Ecological Restoration

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Among Heidegger's most brilliant contributions to environmental philosophy is his devastating critique of modern science's fundamental, technological mindset. The stinking rose that is the bloom of our epoch in the history of being, the experimental method projects and then confirms its view of the world as repeatably present-at-hand, thereby concealing both its own being and the temporality of Dasein. This theoretical distortion, moreover, has had powerful practical consequences. Driven by its fundamental orientation to control, science reveals the world and eventually humanity itself as standing reserve, i.e. as equipment made for consumption by the human will to power. Worse still, Heidegger's frightening picture is undeniably compelling: the last two centuries offer many examples of our achieving tremendous power only to find that, like the sorcerer's apprentice, we cannot constrain what we've unleashed. Our aspiration to power has rendered us progressively more powerless. Yet as compelling as this story appears—and indeed as tempting for environmentalists in the humanities who, denied the economic and political prestige of their scientist colleagues, can at least indulge in self-righteous condemnation—matters cannot be so simple. Any blanket condemnation of science generates intractable theoretical and practical problems—a difficulty not only in general, but for Heidegger in particular as one who sees Dasein's knowing and acting as intimately connected. To sketch the general problem in a thumbnail: many environmentalists, e.g. Holmes Rolston III, praise science as offering essential insights into the beauty, complexity, and wonder of the natural world. For them, one could not appreciate the environment without any insight into its unseen depths. But the practical problem with Heidegger's view is even more pressing for environmentalists, since by apparently rejecting science, Heidegger leaves little or no justification for developing the techniques by which environmental mitigation, revegetation, and (more broadly) restoration may become effective—an enormous problem, given both the environmental degradation that has already occurred and that which will yet occur under the momentum of current practices. Of the many questions that could be raised, I will focus on two interpretive ones. First, does Heidegger in fact reject science completely? And if not, what form could science take once we have conceded and rejected the devastating consequences of understanding science as *Gestell*? Addressing this question is difficult, since it is implicitly an ethical one, and Heidegger's attitude towards ethics was famously astringent. Yet recent work clarifying Heidegger's philosophy of science as well as other work drawing out the ethical implications of his position have suggested between them new possibilities for rendering his powerful critique of technology both performatively consistent and practically plausible.

Keywords: Heidegger, restoration as technology and technique, restoration as listening and enabling.

Evaluation of Agro-environment Schemes in England - A Three Pronged Approach

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Since 1997 we have been evaluating two agro-environmental schemes in England, the Countryside Stewardship Scheme and the Environmentally Sensitive Areas. We have looked at a) targeting of the schemes, b) the way the scheme is being applied and c) delivery of ecological objectives. Results from each of a, b and c will be presented and a synthesis of the effectiveness of the schemes will be made. The schemes appear to have been well targeted, well run and for wet grassland and calcareous grassland have delivered objectives. However not everything is perfect!. Information on the two new schemes that started in England in April 2005 will also be presented.

Keywords: Agro-environment, targeting, scheme management, delivery, success.

Comparison of revegetation of roadside slopes using different sowing mixtures

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The research took place in the sub-Mediterranean part of Slovenia. Two plant species mixtures were sown, one with nursing grasses and the other without them, and tested to determine, which one is better for restoration of roadside slopes. Both sets of plots were sampled every year over a period of six years and analysed (indirect gradient analyses, species number, similarity, syntaxa). It was found that the mix-

ture without nursing grasses with predominating stress tolerators is better, since it enables a smoother succession course.

Keywords: roadside slopes, dry grassland, restoration, floristic composition, permanent plots, succession, Slovenia.

A satellite-based approach to plan fluvial habitat restoration

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The usefulness of remote sensing techniques in analysing landscape structure has been widely demonstrated; whereas the application of these for planning ecological restoration interventions is not thoroughly explored yet. In this study we propose an approach based on satellite data as input for hydrological analyses to identify better sites for restoration ecology interventions in fluvial ecosystems. Among the several existing restoration techniques the construction of buffer strips along fluvial degraded banks is an accepted strategy of ecological restoration for improving water quality and habitat structure. The object of this research is to identify, along a fluvial habitat, critical segments because of the contribution of landscape superficial runoff. The latter is considered as a very important cause for pollutant transporting from fluvial surrounding areas. Such identification allows for precise localizing of buffer strips creation. The study area, the upper part of Agri River Basin, is located in Basilicata region (Southern Italy). This river shows very critical areas along its principal axis because of concrete embankments and widespread agricultural areas in its landscape. Remote sensing techniques were used to obtain a land use map of the territory from a summer LANDSAT-TM (Thematic Mapper) image. This map represented the basis for superficial runoff analyses related to different land use typologies by means of a hydrological distributed model; final data located the segments needing buffer strips creation. Results show that this methodology provides satisfactory information for an efficient intervention planning by evaluating landscape influences for the identification of critical areas in fluvial habitats.

Keywords: Landsat-TM, ecological restoration, fluvial ecosystem, hydrological model.

The assessment of a restored site in a reclamation area along the northern Adriatic coast

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The study was carried out to evaluate the different ecological values of a natural reserve (Valle Vecchia, Caorle-Venezia), S.I.C. and Z.P.S., and develop a management plan of the different zones. The area consists of two parts: a coastal area, charachterized by the dunal system and an anthropogenic pine woodland, and a more developed area, used for agroforestry practices, with two wetlands, some planted woodlands and many hedgerows planted to separate the cultivated fields. We developed and applied a set of indexes to describe the flora and the fauna of the site. The flora indexes include: species diversity (Margalef), biogeographic value, chromatic asset, number of rare and protected species, degree of naturalness of the community successions, sociological behaviour (Ellenberg). The wildlife indexes (birds and waterfowls) include: vulnerability level, biogeographic value, social value: contactableness level, amenity level, hunting value. We also assesed the different anthropic impacts related to the coastal part, which is the most frequented by visitors, and beach users. The diverse floristic composition and the percentage of surface occupied by paths were considered. The zone characterized by the highest ecological value for the flora and the fauna is the same in areas where the human impact is the lowest and in these areas there are very few synanthropic flora species. The indexes allowed us to establish a zoning criterion and distinguish three diverse zones with a different ecological value. The management plan will be based on three different protection levels for the site.

Keywords: indexes, ecological value, restored site, natural reserve, management plan.

Restoration of desert abandoned agricultural fields

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Biodiversity, functionality and productivity are main goals for restoration and rehabilitation practices. When large areas are involved, scaling of restoration goals should consider socioeconomic and desertification amelioration issues. When those issues are not considered, arid lands restoration and rehabilitation are perceived as "wasted" efforts that consume large amounts of capital resources. Abandoned agricultural fields in La Costa de Hermosillo within Sonoran desert habitats, have increased in the last 20 years to a patchy landscape close to 100 thousand hectares. Restoration have been initiated considering previous ecological information on historical accounts, plant secondary succession and resource use strategies of dominant plant species in native desert ecosystems. Rehabilitation considers a matrix of different economic potentialities for specific native and introduced plant species into these new habitats. We conclude this paper reviewing the ecological and environmental considerations for developing a restoration strategy that can be successfully applied to abandoned agricultural fields in desert habitats.

Keywords: desert secondary succession, abandoned agricultural fields, desertification, environmental costs, desert restoration.

Ecological restoration of the gypsum quarry "Rio de Aguas" in Almeria (SE Spain) based on soils and floristic analyses

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This report describes a series of studies aimed at recovering a gypsum quarry area (Rio de Aguas, Sorbas, Almeria, Spain), which through years of mining has suffered intense degradation effects on landscape and geomorphology. The aim of the work was to minimize these effects. It was made a thorough evaluation of the flora and native vegetation of the quarry and its surroundings. The climate and soil of the area were defined and mapped in detail to establish a good time frame for installing a protective plant cover aimed at mitigating erosion-degradation and at integrating the landscape of the quarry within its natural setting. A physico-chemical and mineralogical analysis of the soil allowed to establish suitable amendments for the soil used to cover the area to be restored, mainly in terms of OM, total N and SO_4 contents. Studies of flora and vegetation, specially in natural plant communities, have indicated the presence of numerous species (20% endemic) and their preference for the different landscape units. Thus, some taxa showed a preference for slopes, sunny or shady sites, gypsum substrates or basic non-gypsum materials, and also different soil properties. In addition, based on endemism values and ecological preferences, we are presently creating a stock of seeds and have started greenhouse tests to evaluate the behavior of the different taxa.

Keywords: landscape degradation, soils, flora, vegetation, ecological preferences.

Problematic of hydrologic forest restoration in the semiarid/arid climate: the experiencein the mounts of the Vinalopó basin (Spain)

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Hydrologic-forest restoration in semiarid/ arid climate: the case of Vinalopó basin. Zone in semiarid climate gravely eroded as consequence of as anthropic as climatologic factors, due mainly to erroneous reforestations and adverse climatic conditions characterised for the scanty of precipitation and torrential rains episodes. The treated themes are the problematic of reforestation in these mounts and the necessary actions to get a satisfactory hydrologic-forest restoration in this environment. Application of new techniques for water utilisation. Importance of implantation irrigation. Physic and biologic techniques for erosion correction.

Keybords: hydrologic-forest restoration, semiarid, erosion, water utilisation, irrigation, reforestation techniques.

Varying limnology of the lagoons within the same wetland landscape. A case study from a Ramsar Wetland in Sri Lanka

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Objectives of the present study are to identify the decisive limnological parameters that may be useful in the management of the major lagoons {Malala (650 ha), Embillakala (450 ha) and Bundala Lewaya (550 ha)} in the Bundala National Park (first Ramsar wetland in Sri Lanka). Major limnological parameters were studied in temporal and spatial scale over two years (2001-2003). All the analyses were carried out according to the standard methods described elsewhere. Differences of water level and the drainage systems, magnitude of the forest cover and the varying degrees of human impact were identified as key factors affecting the ecological identity of each lagoon. Sediment loading and sediment retention, salinity, micronutrient levels, Chlorophyll a, phytoplankton, zooplankton, fishes and aquatic birds showed marked differences of their abundance and composition at temporal and spatial scales. Correlation analysis showed the complex relationship between physicochemical parameters and biological characters of each lagoon. Abundance and the composition of the aquatic macrophytes was a key determinant of the biological assemblages (e.g. phytoplankton, zooplankton and fishes). High nutrient levels indicated the danger of eutrophication. Poor drainage systems, uncontrolled human activities, devastated buffer zones and lack of long term monitoring programs were identified as key issues to be considered in future management plans. This study has noted the significant differences of the physico-chemical parameters and related biological parameters between the lagoons within the same landscape indicating the requirement of precisely planned management strategy for each lagoon.

Keywords: Ramsar wetland, physicochemical parameters, Wetland management.

Ecological types of natural lakes and wetlands in the Middle Atlas of Morocco for the restoration of their ecological values

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Research on the invertebrate and vertebrate (birds) populations have been carried out in 13 lakes and wetlands of the Middle Atlas in Morocco from 1990. The objective of these researches was to identify the most important types of aquatic habitats for birds and to remark their importance for the annual cycles of species identified in these types of habitats. Detailed cartographic maps have been elaborated using aerial photographs. Detailed cartographic maps have been elaborated using aerial photographs and extensive *in situ* validation of the plant communities. A typology of the lakes has been established through the factorial analysis of multiple correspondences (AFCM) of 14 variables related to physical, chemical, geomorphological and biological characteristics. This description is used for the classification of the lakes. The spatial distribution of the aquatic bird's populations is in agreement with the lake typology. Most wetlands are disturbed by human activities and also under stress because of drought climatic conditions. Managers and scientists are in agreement for the urgent action to conserve and restore these habitats. The typology obtained after this analysis is proposed as a basic tool for the restoration and sustainable use of these ecosystems.

Keywords: lakes, Mid Atlas, typology, birds, management, restoration.

Restoration ecology to the future for its applicability, predictability, and sustainability

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Since its emergence as a new discipline in past century, ecological restoration has demonstrated an astounding growth and success not only as a proactive tool for conservation and management of biological resources, but also as a "testing-ground" of ecological theories. Particularly, the concepts of community succession have been a focal point for determining 'desirable' restoration trajectories. However, much of such trajectories are problematic under the ever-changing environment because they are often retrospective to the past, based on deterministic and static concepts of communities, limited to historic species composition, and sort of 'ad-hoc gardening' often with anecdotal and nostalgic visions. A simple re-composition of past floras or faunas is not a viable restoration for the future. A new paradigm is needed for sustainable restoration to the future. The new paradigm has to acknowledge (1) changing and unpre-

dictable environment of the future, (2) dynamic nature of ecological communities with multiple trajectories, and (3) interconnections of landscape elements for ecosystem functions and structures. Long-term and explicit goals, monitoring, and evaluation criteria are also essential for sustainability of restored ecosystems. This paper will present a theoretical framework for applications to this new paradigm.

Keywords: restoration ecology, sustainability, paradigm.

The water pollution prevention behaviors in Bangkok

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This paper intended to review and examine the participation behaviors in the water pollution prevention in Bangkok and its vicinity. The participation behavior concerning water pollution prevention among various stakeholders including personal and community levels were examined. The results showed that personal factors such as sex, age, level of education, occupation and other individual characteristics influenced the water pollution prevention for the residents of Bangkok and its vicinity who living nearby the Chao Phrya river and other major canals. Residents of Bangkok and its vicinity had very high levels of the knowledge, attitude and perception toward the water pollution problems due to the effective water quality concern campaigns distributed by the mass media, particularly the television and radio. However, the levels of the participation behaviors were low in action for both personal and community dimensions. This indicated that there was a quite difference between people's thought and behavior in reality. Longer time spent on their own businesses, household tasks and less attention to the practice of local residents were main causes of low levels of personal participation behaviors on the water quality concerns. A lack of local community leadership and/or the ineffective existed local community leader coupled with the ineffective co-ordination and public relation among various agencies such as local community organization, government and non-government agencies were the main causes of the failure in practices regarding to the environment conservation under the basis of the sustainable development. To achieve the high levels of the participation behaviors in the water pollution prevention under the basis of the sustainable development, this paper suggests that local community leadership development and community organization development programs should be emphasized. Revising of laws and official regulations were done also to support the local community to cope with the environmental problems effectively and systematically.

Keywords: Water pollution prevention behavior in Bangkok.

Conservation of dolphins – a tool for sustainable development and management of protected wetland in bihar: a case study in vikramshila sanctuary

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Conventional wisdom suggests that people living in one of the poorest and politically unstable regions of the Asian subcontinent should be more concerned with economic security than with conserving wildlife. But in the Vikramshila Gangetic Dolphin Sanctuary (VGDS) of Bihar, India, a local group of conservationists from Bhagalpur University together with the Whale & Dolphin Conservation Society, U.K. in association with local community has initiated a project to turn a 60km segment of middle Ganges from a Sanctuary that till recently existed only on paper into one that provides meaningful protection for river dolphins and other aquatic fauna. It has also helped in the restoration of the ecology of river Ganges and its fisheries, leading ultimately to sustainable development and management of the Sanctuary. The Sanctuary was designated in 1991 and is the only protected wetland in Asia established specifically for Ganges river dolphins or 'Soans' *Platanista gangetica gangetica*. Vikramshila sanctuary has a rich biodiversity. In addition of Ganges river dolphins, our survey team has recorded gharial crocodilians *Gavialis gangeticus*, Smooth coated otters *Lutragale perspillata*, a variety of hard shell turtles, 76 numbers of fish species, 2 species of crustaceans and 135 species of birds. Bird species include 32 species of migrants including Greater Adjutant Storks *Leptoptilos dubius*, species that had never before been recorded in the Ganga Basin. In May 2002, we found nesting sites of Small Indian Pratincoles (*Glareola lacteal*), Indian Skimmers (*Rhynchops albicollis*), Indian River terns (*Sterna rantia*), little terns (*Sterna albifrons*) and river lapwings (*Vanellus indicus*), on a sandy mid-channel island near Bhagalpur. We also documented rich angiospermic vegetation along the river bank and in the flood plains, including 36 species of dicots and 15 species of monocots. Thousands of fishermen and farmers families live adjacent to the river and depend on the river-resources for their livelihood. The biodiversity in the Vikramshila Sanctuary is threatened today. The aquatic wildlife including dolphins are particularly vulnerable to the human activities because

of their restricted habitat. In Vikramshila, threats generally include, - 1) accidental as well as deliberate killing of dolphins for dolphin products such as dolphin oil, 2) violations of fishery and other environmental regulations, 3) poaching and hunting of the wildlife, 4) excessive exploitation of river resources, 5) pollution of the river, 6) poor socio-economic condition of the local resource-user community, and 7) the threat of violence in the river, VBREC team has taken some conservation initiatives including awareness and environmental education programs, and that are showing encouraging results towards conserving the rich biodiversity of the river Ganges and The Holy! Mother Ganga itself.

Keywords: dolphin, wetland, Vikramshila Sanctuary.

Butterfly Communities on Restored Landfills in Hong Kong

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Closed landfills are usually revegetated to mitigate visual impact and provide amenity land. In Hong Kong, there are 13 closed landfills with a total area of 270 ha, which are important source of land for conservation and recreation. Most ecological research on local closed landfills focuses on vegetation and soil development, and there is a paucity of information on the recruitment of animals during successional changes. The diversity status of butterflies which are good indicator of ecosystem development have been studied on landfills, but are mostly limited to temperate countries. An assessment of the butterfly communities was conducted on four restored landfills, *viz.* Gin Drinkers Bay (GDB), Siu Lang Shui (SLS), Tseung Kwan O Stage I (TKOI) and Tseung Kwan O Stage II/III (TKOII/III), in Hong Kong which is subtropical. Monthly censuses were carried out on each site by the transect method between June and November, 2004; each site was visited five times. A total of 75 species from eight families were found. Major species included *Ypthima lisandra*, *Euchrysops cnejus*, *Famegana alsulus*, *Lampides boeticus*, *Zizina otis*, *Eurema hecabe*, and *Euploea midamus*. Most were common on non-landfill areas, but four uncommon species were found, *viz. Pachliopta aristolochiae, Delias hyparete* and *Eurema brigitta*, and the very rare *Taractrocera ceramas*. Mean butterfly density for each site ranged from 84/ha to 360/ha. SLS had the lowest diversity index (1.75), while TKOI had the highest (2.18). Local closed landfills provided a suitable habitat for butterflies and were potential refuges for some rare and uncommon species.

Keywords: Butterfly, colonization, restored landfills, Hong Kong.

An innovative approach of reservoirs habitat restoration, in the Guadiana river basin, Spain

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The aim of this project is to establish wetland ecosystems in the vicinity of restored reservoirs. With the use of innovative restoration techniques, like, creation of artificial islands, artificial reefs, dikes, nesting sites, revegetation of banks, Confederación Geográfica del Guadiana, has been creating new wetland ecosystems in a pair of reservoirs. These actions took into consideration the public aspect of the site for recreational use or as a scientific site. The wetlands have already developed a higher biodiversity.

Keywords: reservoir restoration, wetland, biodiversity.

Making priorities and selections in wetland restoration; experiences in the province of Friesland, The Netherlands

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General rules and measures from 1970 onwards resulted in a distinct improvement of surface water quality (mainly related to oxygen conditions), after a long period of severe water pollution in The Netherlands. However, because of intensification of uses of our environment, with often contradicting interests, severe environmental problems became more visible, like eutrophication, acidification, desiccation, fragmentation and recently effects of climate change. Related to functions of water systems restoration and rehabilitation measures started around 1990 in the province of Friesland. A limited number of projects in nature reserves have been realised triggered by governmental subsidies and from the principle first come, first served. Nowadays a more well-considered setting of priorities is needed. In this paper two examples will be presented of methods used by setting priorities (in time) between areas, and three by making

choices between measures within a limited area. One of this is a costs-effectiveness study, showing the approach needed according to the EU Water Framework Directive. It's concluded that there is not yet a clear policy is using decision support systems in regional water management, nor in a set of standardised instruments for preparing weighed decisions for wetland restoration.

Keywords: Environmental degradation, functions of water systems, priorities and selections in measures, regional wetland restoration.

Assessing the success of restoration planting in Hamilton City, New Zealand

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Hamilton City (New Zealand) is the focus of a concerted public and private effort to retrofit the City by restoring and reconstructing indigenous ecosystems. To date some 187 ha of land or 2% of the City area is being actively restored comprising 142 ha on public land and 45 ha on private land. In order to determine how successful previous restoration plantings have been in achieving desired ecosystem states and to guide future projects, research was undertaken on a range of restoration plantings within the City. Some 62 variable area plots were measured to cover the range (chronosequence) of planting ages (0-30 years), maintenance treatments (low vs high), and initial states (bare vs existing canopy) on gully slopes, the landform on which most of the restoration planting in the City occurs. Data collected from 4 plots in natural regenerating forests within or near the City were used as baselines to assess progress towards establishment of natural functioning ecosystems. Results showed that it is comparatively easy to establish a low diversity indigenous forest canopy on bared sites within 20 years, and by this stage, some early maturing canopy species will be starting to regenerate. Indigenous ferns, including tree ferns, colonize the restored stands unaided. Although restored stand basal areas are comparable with natural regenerating forests, the excessive use of well known pioneer plants and the tendency for failure of early planted mid- and later successional species leads to stalling of forest development. From 20 years on, the indigenous restoration plantings decline in indigenous species richness and cover and there is an increase in exotic species colonization especially in canopy gaps. Amongst the colonizers are several troublesome weeds (e.g., Japanese honeysuckle) with the potential to out compete indigenous species. Because of isolation and lack of seed sources, the expected mid- and late-successional shrub and tree species need to be introduced to the restored stands via enrichment planting or seeding. Most management programmes fail to recognize this requirement and valuable progress is lost. The challenge now is to build the lessons learned from this research into new and existing restoration planting programmes in the City.

Keywords: urban restoration, restoration planting, forest development.

Restoration of a cut-over peat bog in northern New Zealand

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Torehape peat bog in northern North Island, New Zealand, is currently being mined for horticultural peat. The miners are required to restore the area to original bog vegetation once the permitted depth of peat has been removed. We established a restoration trial on the mined peat surface to determine the best practical approach to restore vegetation cover. The trial involved combinations of water table, peat cultivation techniques, nutrients (N and P), and seed additions (the heath shrub *Leptospermum scoparium* [Myrtaceae] and the restiad *Sporadanthus ferrugineus* [Restionaceae]), characteristic of both early and late successional stages of bog development. The most effective treatments were raised 'islands' of processed peat seeded with small branches of *Leptospermum* laden with ripe capsules, which reached 100% vegetation cover within two years. The miners adapted this approach to restore a larger area (200 ha) of mined peat. We assessed the effectiveness of this upscaled approach by monitoring vegetation and invertebrate recovery at intervals following island establishment, and comparing patterns and trends with peatland buffer baselines. Results showed key peat-forming species such as *Sporadanthus*, *Empodisma minus* (Restionaceae), and occasionally, *Sphagnum*, had established naturally within two years, indicating the developing *Leptospermum* shrubland acts as a nurse for other bog plant species. As vegetation cover and species richness increase, invertebrate composition and abundance become more similar to that of the buffer. This simple low-cost approach speeds up peatland recovery and gives significant biodiversity benefits.

Keywords: restoration, cut-over bog, vegetation, invertebrates, monitoring.

Ecophysiology of California and Mediterranean grass species: implications for restoration of xeric grasslands

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California native perennial grasslands have been largely replaced by non-native annual grass species of Mediterranean Basin origin, and some areas are currently being invaded by Mediterranean perennial grasses, presenting a new barrier to restoration of California grasslands. Some ecophysiological characteristics of grass species may be directly correlated to their success in California grasslands, especially traits that relate to their tolerance of California's intense summer drought. We measured a range physiological parameters, particularly traits correlated with plant water relations, of four dominant California perennial grasses, four dominant perennial grasses of Mediterranean Spain, and three invasive Mediterranean annual grasses, all grown in containers under controlled conditions. Though California and Mediterranean perennials were more similar to each other than to the annuals, California perennials displayed several traits that were intermediate between Mediterranean perennials and annuals. California perennials seedlings grew faster than Spanish perennials, had higher specific leaf area, and exhibited lower resistance to hydraulic flow in roots. In a greenhouse trial with watering regimes simulating central California average precipitation, California perennials produced earlier and more numerous seed spikes, and showed much higher survival over the summer drought cycle than corresponding Spanish perennials. These results suggest that Mediterranean perennial grasses may have a difficult time invading California grasslands, except where water-balance conditions are ameliorated by microsite effects or maritime weather influence. Additionally, the apparent presence of "annual-like" traits in California native perennials may be seen an effective adaptation to current California conditions, or as an intermediate strategy vulnerable to competition from vigorous annual competitors.

Keywords: Grasses, ecophysiology, Mediterranean climate, competition.

Legal opportunities and constraints for ecological restoration in Europe

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This study looks into international legal possibilities and difficulties for ecological restoration. It will give an overview of new environmental law principles such as the restoration principle and ecological compensation principle. It will analyse the provisions on ecological restoration worked out in the framework of international nature conservation treaties such as the Ramsar Convention and Biodiversity Convention. It will focus of the question whether these provisions have a direct applicability or need implementation in national legislation. Specific focus will be given to the EU Birds and Habitats Directive. International and national legislation will not only provide for possibilities for ecological restoration, but will sometimes render restoration plans more difficult. Replacing one type of ecosystem (such as a forest) by another type (such as heather) or reintroducing species will often be prohibited in nature conservation legislation or will require special permits. The question is whether legislation should provide exceptions to these prohibitions for the benefit of ecological restoration measures. Although this is certainly desirable, it must be done carefully. Creating exceptions might lead to abuse of law. Also, social requirements have to be taken into account: when exceptions are allowed to enable ecological restoration measures, this might be regarded as discriminatory by other user groups. The challenge for legislation will be to facilitate ecological restoration, without loss of quality of ecological restoration measures and loss of public support.

Keywords: ecological restoration, Ramsar Convention, Biodiversity Convention, Birds Directive, Habitats Directive.

Rivers 2nd Nature: The River Dialogues

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The 3 Rivers 2nd Nature project was directed by artists/researchers Tim Collins and Reiko Goto. The project addressed the meaning, form, and function of public space and nature in Allegheny County, PA, U.S.A. The intent of the project was to reframe the interest, discourse and planning for aquatic and terrestrial ecosystems. Focusing upon practical studies conducted with scientist the project developed a rigorous set of baseline data – which was then complimented by regional planning and policy studies to un-

derstand the effect of existing institutional actions, regulations and enforcement mechanisms had on long term ecological viability and/or recovery. I will present a powerpoint overview of two or three case studies, one the "Pittsburgh Hillsides" zoning study, two the "Clean Streams" initiative and three the "Rivertrails" project. I will show how this team of artists, scientists, planners and attorneys collaborated on creating visual, conceptual and social "tools" that aid and abet citizen involvement in the aesthetic recovery of the post industrial public realm.

Keywords: art, terrestrial, aquatic, mapping, radical planning, policy.

Rehabilitation os arsenical sulphidic gold mine. A case history at Stawell Gold mine, Victoria, Australia

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This project was designed to develop ecologically sustainable methods of revegetating areas impacted by gold mining, a common resource exploitation in the state of Victoria, Australia. As toxic soils are poor or even difficult substrates for plants to grow on, the creation of a self-sustaining vegetation community on contaminated land requires the substrate to be suitable for plant growth. Chemical and physical analyses of substrate samples are a fundamental part of the planning and implementation of any rehabilitation project, providing vital information on the nutrient status, toxicity and structure of the substrates.

The aims of this research were: to evaluate the growth of plants in different concentrations of calcium sulphate and tailings. To identify and quantify toxic metal and metalloid uptake in plants grown in different concentrations of tailings. To define the optimum chemical and physical conditions of soil cover for plant to grow over tailings bed. To identify chemical and physical changes in tailings after three years of being covered with three different treatments. The data obtained from this study are used to develop a strategy that integrates soil treatments with the selection of plant species that are tolerant to toxins or rehabilitation of mine wastes (tailings) at Stawell Gold mine, at present the largest gold mine operating in Victoria, Australia. The concentration of gold in the rock mined for 1km depth is about 5 g per ton. To extract the gold, the sulphidic rocks are crushed and processed, resulting in the production of fine-grained tailings. These are pumped as a slurry into tailings lagoons and slowly dewater. The tailings are sulphidic wastes enriched with arsenic (about 2,000 ppm) and heavy metal toxins. The results obtained in this study, also show that tailings contain other secondary minerals aside from gypsum, further limiting their potential as a medium for plants growth and survival.

Keywords: ecologically sustainable, gold mining, plants growth and survival.

Influence of landscape structure on the effectiveness of Spanish agri-environment schemes

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Recent work has suggested that the failure of some agri-environment (AG) schemes to restore biodiversity could be partially due to reduced recolonisation rates and/or source populations in simpler landscapes. We analyse whether the effectiveness of AG schemes (i.e., increase in species richness of birds, plants, bees, grasshoppers and spiders between paired fields with and without schemes) are influenced by landscape traits at the field scale and at the scale of the landscape surrounding fields. Selected landscape metrics were measured at the two scales: size and shape of focal fields and types of boundaries (field scale), and cover of land uses, length of three types of boundaries and measures of landscape structure in 500-m circular buffers around field centres (landscape scale). Landscape metrics were summarized by means of three Principal Component Analyses, one for field-scale metrics and two for landscape-scale metrics, one estimating landscape connectivity and the other the diversity and type of land uses. Species richness and landscape traits were measured in three study areas in Spain differing in landscape complexity (amount of natural vegetation interspersed within fields), following a sampling design developed in the V Framework project 'Evaluating current European agri-environment schemes to quantify and improve nature conservation efforts in agricultural landscapes' (EASY). Our results suggest that effects on landscape on effectiveness of AG schemes are non-linear, including threshold values of landscape complexity and saturation effects.

Keywords: AG schemes, landscape structure, effectiveness, biodiversity.

Life Corbones: project of ecological and social restoration of the average section of the Corbones river

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The Corbones, is a river that crosses the province of Seville of the Southeastern towards the northwest, ending finally at the Guadalquivir. The degradation state in which it is, must to the abuse of the resources of its river basin fundamentally, uses that they have relegated to the river to the total abandonment, transforming itself into a mere water channel in which still they persist in some sections, structural characteristics of the ripario ecosystem thanks to the plasticity of the own nature before the impacts generated by our out of proportion development. From this situation of natural degradation, the Life Corbones arises, like project that tries the integral restoration of the average section of the Corbones. Their objectives have been planned from the development of three basic pillars: Control of the quality of waters, by means of the establishment of a network of sampling stations. Approach of the population to the values of the river by means of an integral program of sensibilización and environmental awareness. And finally, the environmental restoration of the zones more degraded by means of the accomplishment of a project of restoration based on purely environmental criteria and by means of which it is tried to give back to the structure and operation to the fluvial ecosystem, environmental restoration that is going away to describe in presents communication.

Keywords: ecological restoration, fluvial ecosystem, vegetation of shore, management of river basins, quality of water.

Environmental plan of the Ebro river and the low section of the Cinca river: a new approach for rivers restoration

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The environmental Plan of the Ebro River and the low section of the Cinca River, arises as a result of the floods produced by the Ebro river in February 2003. The main targets of this Plan are: first of all, the protection of the population and properties, secondly the protection and improvement of natural ecosystems associated to both rivers and thirdly, the promotion of the sustainable development of the river-side municipalities, through the encouragement of leisure activities linked to the rivers. Before approaching the performance of these proposals, it has been necessary to have a precise knowledge of the river and its surroundings, for which various aspects related to the physical, biotical and socioeconomic resources, have been analyzed. In addition, a proposal, of which should be the best stream-dynamics corridor (free area of water courses) that allows the river to recover part of its former river dynamics (now-a-days partially restricted by the numerous existing artificial defences), has been developed. At the same time, inundability and risk maps have been made. These drawings will be used to establish the most suitable proposal of uses in each section of the floodable area. Afterwards, this proposal of uses, will be materialized in an strategic Plan, in which in addition, the distribution of responsibilities will be determined, The project looks for, by means of the acceptance of all the implied administrations, the sustainable development of the shores of both rivers. For this purpose, the institutional frame of the plan will be established. Besides, possible sources to finance this Plan are being searched.

Keywords: Ebro river, floodplains, stream-dynamics corridor, sustainable development.

Ecosystem function and restoration success: are they related?

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Evaluation of restoration practices is needed to determine the degree of success of restoration programmes and improve restoration protocols. Environmental, biological and social constraints must be considered, together with restoration objectives, when evaluating restoration success. Thus, in stressful, unpredictable environments, evaluation should consider climatic conditions and disturbances occurring during and after the intervention. The degree of degradation may also affect restoration success. Assessment of current ecosystem state should be incorporated into procedures for evaluating restoration actions, and efficient diagnostic tools should be developed. However, information on the relationship between ecosystem state and

the chances of restoration (for short 'restorability') is scarce. Restoration theories suggest that restorability may be inversely related to degradation state. But there is increasing evidence that alternate ecosystem states do not necessarily follow a trajectory of increasing ecosystem complexity (composition) and function, suggesting that restorability could be independent of ecosystem state. We have related degradation state and restorability in 17 alfa grass (*Stipa tenacissima*) steppes in SE Spain. We evaluated degradation state by using the Landscape Function Analysis method developed by D. Tongway and colleagues (LFA indices being positively related to ecosystem function). We estimated restorability by determining short-term survival and growth of seedlings of *Pistacia lentiscus*, a late successional keystone species in alfa grass steppes. LFA indexes were related to several aspects of community composition and structure, mainly the cover and spatial pattern of sprouting shrubs. The presence of sprouting shrubs was highly related to the number of perennial vascular plants. In contrast to our expectations, results suggested a negative relationship between ecosystem function and *P. lentiscus* performance. We will discuss the validity of these results in a general context, and we will emphasise the need to further explore the concept of ecosystem restorability within the framework of restoration appraisal.

Keywords: restorability, restoration evaluation, ecosystem degradation, alfa grass steppe, LFA.

Restoring the lowland agricultural landscape of the Severn Vyrnwy floodplain

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The Severn Vyrnwy Land Management Initiative piloted a process of integrated rural development that lead to opportunities to restore target habitats and address other aspects of sustainable land management. Implementation was undertaken by: 1. Developing components of a Sustainable Land Management Framework to guide change. 2. Offering a farm business development service 'Farm Focus' that integrated business and environmental support. A four year implementation period brought the following results: 1. Five ecoscapes were characterised: Flood Plain, River Terrace, Driftplain, Sandy Slopes and Peatland. Each ecospcape is conceived as a unique envelope of ecological processes operating at landscape scale whose spatial extent has been defined using geology, terrain and soils and related to land cover, landscape character and historic landscape character. A GIS-based environmental record and concensus building with key stakeholders to agree land management priorities were initiated as the first steps towards agreeing a sustainable land management framework. 2. 400 ha farm land were converted to semi natural habitat: including 33ha wetland, 140 ha over-winter stubble, 180 ha low input grassland. Economic links between farming and local community were established to promote opportunities in the 'green economy' to provide economic incentives to improve environmental performance. Conclusions: Engaging in a process of pro-active rural development created many opportunities to restore the agricultural landscape. 'Ecoscapes' provide a rigorous scientific base on which to build a Sustainable Land Management Framework.

Keywords: Agricultural landscape, ecoscapes, biodiversity targets, implementation.

Integrated Restoration of Arid Lands and Farm Economies

Cunningam S.
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"This session will discuss the importance of integrated strategies for the restoration of arid lands. Integration can take place along two axes, and of which can contribute significantly to the project's technical success, the funding available to it, and the public/political backing for it. The first axis integrates the ecological restoration of the arid land with the other "sectors" of restorable assets: watershed, agricultural lands, fisheries (if coastal, estuarine, or island), contaminated lands, infrastructure, heritage, and catastrophe damage. The other axis integrates the various types of individuals and organizations who can or should be involved: academic, governmental, NGO, and business. The audience will be introduced to the two rating systems recently developed by Revitalization Institute: one for Integrated Restoration Projects, and the other for Integrated Revitalization Programs. These rating systems are designed to be universally applicable to projects, communities, and regions of all sizes, whether in developed or less-developed countries."

Keywords: integrated restoration, integrated revitalization, rural revitalization, arid lands restoration, ecological restoration.

Chicago´s first fish hotel – habitat creation in the urban core

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This presentation addresses the theme of creating suitable habitats within an urban inner core. The project is a floating fish habitat located on the Chicago River. The Friends of the Chicago River, a citizen group working towards the ecological health of the river, commissioned the pilot project to be implemented in the summer of 2005. The challenge is to create a viable aquatic habitat within a set of urban constraints. A central channel must be maintained as navigable waters. The wall along the site of the fish habitat is weak and therefore much of it cannot be used for anchoring the habitat structures. No contact can be made with the river bottom. Special attention must be given to the wake created by the numerous vessels that use the channel. The water level fluctuates normally by two feet and up to seven feet on rare occasions. Because of these constraints the final design makes use of floating native wetland habitat and suspended underwater aquatic cells that attract the desired native fish species and keep the relative depth to surface ratio steady under any fluctuation event. The public can view the floating wetland from the river walk above the site and can witness the underwater activity of the aquatic life it attracts, via video and sonar, on monitor stations placed nearby. The project will be monitored throughout the summer and the information presented at this conference. The project is a prototype to be applied in similar urban settings anywhere, utilizing local flora.

Keywords: urban settings, suitable habitats, fish.

Soil invertebrates as bio-indicators of environmental change in a natural area converted from agricultural use. Vallevecchia - Lugugnana case, North-Eastern Italy.

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When used as bio-indicators, invertebrates represent a valuable tool to scan environmental state and change over time and space. Peculiar natural and ecological features make Vallevecchia, a 700 hectares estate on the North Adriatic coast, a special regionally owned site for testing soil bio-indicators responses to change of use. In the early Sixties, reclamation of coastal marsh took place for agricultural purposes and a pine-wood planting converted the formerly wild area into intensive farming, with altered microclimate, soil and vegetation profile and a simplified environment. Since the Nineties, works were carried in order to thin out the pine-wood belts along the see, to plant hedgerows and bring back part of the area to the original state. In this area seven key sites have been chosen for soil invertebrates sampling, as bio-indicators of environmental conditions. The sites include: pine-wood belt along the cost, holm-oak paths inside the pine wood, two areas flooded by seawater and freshwater to form small shallow lakes, one field cultivated with traditional techniques and one under organic cultivation, and finally the deciduous hedgerow running along the latter. Sampling has been carried out in these sites according to three different methods: modified Tullgren, hand sorting and pitfall-traps in order to collect respectively micro-, meso- and macrofauna. From the first data collected, the importance of the deciduous hedgerows is demonstrated as bio-diversity reservoirs. Vallevecchia hosts important groups of the soil fauna as carabids (mainly concentrated in large open spaces, as cultivated fields, where they can easily search for their preys), lombricidae (frequently found in wet non too sandy sites), isopods and mites of different groups, whose distribution is heavily influenced by the variety of ecological features.

Keywords: soil bio-indicators, deciduous hedgerows, Vallevecchia.

Targets for restoration of old-growth redwood forests: quantifying horizontal and vertical structure

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The horizontal and vertical stand structure in three old-growth redwood forests located on alluvial flats in Northern California is currently being quantified. The objectives are to increase our understanding of what are old redwood forests and to guide future management decisions in restoration efforts. All tree stems within the sampling area are being mapped. Species, dbh, height, crown ratios, and canopy strata

class are recorded and used to summarize individual stand and stand component characteristics (i.e., density, BA, mean diameter and height along with their distributions and measures of variability). The horizontal spatial pattern of tree locations at each site will be characterized using Ripley's K-function. The scale and pattern of variability in crown occupancy in 3-dimensional space will be examined using semivariance analysis. The amount and size of canopy gaps at each site will be determined in GIS by using crown radii data, mapped stem locations, and crown shape parameters. A principal component analysis (PCA) will be performed to reduce the dimensionality of the data and identify the relative importance of structural features and combinations of variables that contribute to structural heterogeneity.

Methodology and preliminary results are discussed in the context of a starting point to quantitatively define the structural complexity of old-growth redwood forests. Structural features and spatial patterns common to study sites are discussed in the context of targets and reference conditions for providing better insight into how silvicultural treatments can be used to promote or accelerate old forest characteristics in young stands.

Keywords: Restoration, redwood, *Sequoia sempervirens*, spatial pattern.

Analysis of fluvial degradation in a humanized catchment (Henares River, Central Spain): Proposals for restoration and corrective measures

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Age-old alteration of catchment and intensive consumption of water resources are superposed in the Mediterranean Region, and the consequence is a strong river degradation. The present work links major alterations in a humanized catchment in the central part of the Iberian Peninsula (the Henares River Basin) with ecologial conditions of aquatic communities, and it proposes restoration an corrective measures. The benthic macroinvertebrate community was selected as the best indicator for assessing the ecological condition of aquatic community. This communiy was sampled in 27 fluvial reaches during the hydrological year 1999-2000. Assessment was linked using multivariant techniques with physiograpphy –geology, topography an climate– and humanization –agriculture, river regulation, human population and industrial activity– of subcatchments, and with enviromental characteristics of fluvial reaches: physico-chemistry, morphohydrology, benthic granulometry and riparian vegetation. The following alterations were obeserved, with restoration and corrective measures being proposed: 1) water pollution associated to urban wastes, that needs a better depuration; 2) flow reduction downstream reservoirs, that demands to establish and maintain ecological flows; 3) degradation or elimination of riparian vegetation, that promotes sandy bottoms, for which it is proposed restoration of both, riparian vegetation and river benthos; 4) straightness and channelization of many reaches, for which it is proposed restoration of the natural bending channel.

Keywords: Henares River Basin, Anthropogenic degradation, Restoration, Corrective measures.

Evolution analysis of local revegetation on mining waste material in Alloza´s coal mine final pit. Andorra (Teruel)

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The research is developed in a final open-coal pit characterized by its heterogeneous soil materials (unclassified mining waste, coal washed piritic wastes), the lack of topsoil and available nutrients and the climate contrast. The main achievement pursued is the creation of an ecosustainable wetland, by recovering the habitat through the water surface's implementation (acid drainage correction and waterweed incrementation) and the revegetation of the furthest zones previous soil conditions correction; also, an environmental integration is pursued by using local vegetation and by recovering traditional uses. Thirty three plots with fifty individuals each are established using local vegetation, chosen for being the most representative and the best adapted species; there are also, sixty plots distributed around the two principal ponds with just one specie each: *Juncus acutus* o *Scirpus holoschoenus.* In plots, hazardously chosen, it is added, mixed with the soil material in every plantation hole, a product known as Terracottem. A follow through is done, every four months, to check the plant's health, based on the leaves and shoots appearance. The oxidation of the iron sulphide (Fe_2S), existing in the piritic wastes, will generate surface acid drainage on the plantation holes provoquing the massive mortality of native vegetation. The mortality percentage has not distinguished between plots with or without Terracottem®. Improving soil conditions treatments are proposed, previous to any other practice, as well as passive drainage treatments to

correct the low pH of the new drowned surfaces. Revegetation management recommendations are also suggested.

Keywords: acid mine drainage, mining restoration, Terracottem®, ecosustainable wetland, piritic wastes, revegetation.

Nature restoration in Flanders (Belgium): state-of-the-art and lessons for the future

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In the very densely populated region of Flanders natural ecosystems suffer from fragmentation and overall ecological degradation. Nature restoration is essential to develop functional ecological networks and to alter biodiversity loss. A database was compiled with 543 documented nature restoration projects in Flanders. This increases our insight on scale, former land use, measures, ecological targets, management and results of nature restoration efforts in Flanders. Some projects were studied in more detail and enable us to identify rules of thumb for successful cost-effective measures. Successes and failures are equally important in this respect. Data were also gathered on legal and social aspects. The database is a source and base line for future multidisciplinary research and reference projects can be identified to promote successful nature restoration. Our study clearly illustrates the need for solid, multidisciplinary coordination and scientific research in restoration planning and for monitoring or surveying afterwards. Both are essential to convince decision makers and the public that nature restoration is crucial in a sustainable development policy for the local communities.

Keywords: review for Flanders, bottlenecks in planning and evaluation of nature restoration, need for multidisciplinary approach.

Tree Cover and Grassland Diversity as an Indicator of the Restoration Status of the Espinal Agroecosystem in the Mediterranean Zone of Chile

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The anthropogenic savannas (Espinales) represent the most widespread agro-ecosystem of the Mediterranean area of central Chile. It presents a complex and heterogeneous, savanna-like structure, with herbaceous and woody strata. The current land use system of the Espinal has resulted in considerable heterogeneity at the landscape level, which is associated with different covers of the legume tree, *Acacia caven*. In this work, the relationships between woody cover and ecological and agronomic variables of herbaceous communities were studied in 29 plots of 1000 m^2 distributed along a 23,000 ha transect. A detrended correspondence analysis of the species x plots matrix explained 73% of the total variation and revealed the existence of two trends of variation in floristic composition: one associated with woody cover and the other related to physiographic position (hillsides and flatlands). Woody cover was correlated with above-ground biomass of herbaceous vegetation, and soil fertility (organic matter, nitrogen and phosphorus concentration), both on hillsides and flatlands. The relationship between woody cover and herbaceous plant species richness was significant and unimodal in flat land areas, and linear, and marginally significant, on hillsides. These patterns of variation allow to predict the consequences of various scenarios of land use and to focus restoration practices. The restoration of the degraded Espinales in order to increase woody cover up to 50% or more, would increase the naturalistic values and the stocking rate capacity of the region.

Keywords: species richness, grazing, geomorphology, land use, woody plant cover.

Agricultural land use and interactions with biodiversity in Scottish river catchments

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There have been major changes to land management on fertile alluvial soils in floodplains, and this represents a legacy of alteration and degradation. Intensification of pastoral and arable agriculture has resulted in a loss of remnant biotopes, a steady decline in farmland wildlife and a deterioration of water

quality. Alluvial soils and the riparian zone represent the interface between terrestrial and aquatic ecosystems, an ecotone of immense value to both terrestrial and aquatic ecology. This project represents the ecological component of a larger environmental project with the general aim of investigating the relationships between alluvial soils, agricultural management, riparian corridors and effects on water quality and riparian ecology. The ecological component aimed to determine the effectiveness of rural Best Management Practices, especially buffer strips, for achieving improvements in water quality and ecology. Watercourses with degraded riparian vegetation, on-going riparian habitat restoration (buffer strips) or long-standing semi-natural riparian habitat were selected within the Tarland and Ythan river catchments. The following questions were asked: Do riparian buffers result in semi-natural habitat or rank vegetation (trade-off in function)? What riparian wildlife associates with established, degraded and recently buffered watercourses? Particular emphasis was placed on the prevalence of flowering plants and associated insect pollinators, the presence of riparian versus terrestrial Coleoptera, and bird and bat populations. In summary, the remedial management of riparian zone had a favourable effect on the concentrations of diffuse pollutants in freshwater, and there are early indications of a recovery of freshwater invertebrates and improved fish stocks. However, buffer strips established in the context of intensive, neighbouring agriculture seem to develop rank vegetation of limited value to truly riparian wildlife species.

Keywords: Floodplains, pollution, riparian biotopes, riparian wildlife.

Conservation Ecology of Himalayan Wetlands and Glacial Lakes: Combating Climate Change through Community Participation

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Himalayan wetlands and Lakes being integral to a pristine ecosystem are hotspots of biodiversity. As sources of potable water, ethno-biological resources and as tenets of socio-cultural elements these are also important components of life supporting system for the highlanders.

Recent trends in climate change have challenged these niches with threats of habitat destruction, biodiversity loss and ecological hazards. Potential catastrophes due to glacial lake outbursts floods, and drying up of perennial high altitude fresh water lakes are immediate consequences of global warming, whereas changes in wetland vegetation dynamics, aquatic biodiversity depreciation and habitat impairment are assessed long term impacts.

Studies further reveal that resource constrains, geographical remoteness and lack of updated expertise further aggravate the situation with socioeconomic impacts like transmigration of the highlanders, changes in land use patterns and exploitation of natural resources.

This paper analyses the ecological impacts of climate change in high altitude wetland ecosystems in South East Asia and its socio-economic implications with reference to glacial lakes of Bhutan and Nepal Himalayas. Recent devastating flood in the Indo Nepal border areas as a consequence of glacial lake outburst have triggered criticality in trans-border water woes between the countries. However, Royal government of Bhutan has installed integrated community forestry programme to combat the climate change that cognates with maintaining 72.5% of pristine forest cover in the country.

Given the constraints common to South East Asian Socio-economy, community participation and locale efforts prove to be the only immediate solution to address the global problem. Awareness drive for natural resource management and critical ecological thresholds, training to run monitoring stations, develop early warning systems for GLOF through alternate communication structure, mitigation and disaster management plans involving the local stakeholders and preserving value added cultural rituals can atleast minimize the aftermath and reduce the pace of ecological deformation.

Key words: global warming, lakes, wetlands, Himalaya.

Self-decomposing laboratories to process PCB-contaminated soil through oyster-mushrooms as methology for ecological restoration

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Sculptural Experiments--Biotechnological Soil Redevelopment, Short-term Interventions in Public Peripheral Zones for Contaminated Industrial Sites--Experimental Methods Between Art and Science. In 1993 when I became attracted by the idea that one gourmet mushroom, species of oyster-mushrooms which have a unique ability to decompose soil contaminated by PCB (PCB = Polychlorierte Biphenylen/polychlorinated biphenyl) without getting toxic itself. Oyster-mushrooms mycellium is split-

ting off PCBs chemical structures into non-toxic substances which could be used to recultivate industrial ground contaminated by PCB and to decompose several waste. Could this knowledge be transfered to temporary site specific artworks designed for mostly industrial sites and former army bases as method of ecological restoration? Since 1999 I am researching such possibilities under various climatic conditons. A future vision is to create itemized systems of sewage plants for soil bioremediation by plants therefore I am researching and developing additional biological systems in colaboration with scientists. A final aspect would be that art is becoming open to visions of awarness and responsibillity for environmental, social and political issues related to independent, interdisciplinary international network: co-operation of artists, scientists, media and economy by using eachs' potential of creativity for the future.

Keywords: soil remediation, cooperation arts and science, experimental approaches through the arts.

Strategic partnerships of journalism and media for scientists, researchers, philosophers and artists to the developing knowledge aboutecological restoration to the public, to political and economical decisions makers

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To keep it very simple, it is about required changes in educational programs for public schools and universities through interdisciplinary teaching and the integration of journalism into all studies. bridging arts, science and journalism (connecting them how they can benefit from each other)

Keywords: strategic partnerships, interdisciplinary education, restoration, eco-journalism.

Complementary hydraulic technique for one-dimensional ecohydraulic modeling in fluvial habitat restoration studies

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During the last two decades, much research on various aspects of the ecohydraulic modelling of rivers has been conducted, including habitat suitability criteria, habitat computation methods, and interpretation of the habitat-discharge relationships. However, less investigative effort has been devoted to the analysis and improvement of the one-dimensional (1D) hydraulic methods for water surface level (WSL) modeling. This paper explores an enhancement of the simple 1D techniques for WSL simulation. The new model "WEISB" is presented and tested; WEISB is applicable in cross sections where the flow is steady, uniform, and turbulent over a hydraulically-rough channel. The model considers the hydraulic resistance by means of the Weisbach-Darcy´s equation, adapted to open channels. This method includes a particular variation of the effective roughness with discharge (Q) in each cross section, which can be either deduced from the observed values of WSL and Q or determined based on the channel features. This model has been tested with data sets representing three basic habitat types (riffle, run and pool) in three types of streams (high-gradient, medium-gradient and low-gradient), extracted from Instream flow studies carried out in California (USA). The results reveal that WEISB has a good ability to simulate WSLs and shows an interesting balance between the data acquisition cost and reliability. In spite of application to hydraulically complex situations, the simulation capability of the new model is comparable to traditional methods and more accurate in certain habitat types.

Keywords: hydraulic modelling, aquatic habitat, habitat simulation.

Optimization of the hydraulic modelling in the PHABSIM aquatic habitat analysis for ecological restoration of rivers

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During the development of an aquatic habitat analysis, it should not be forgotten that hydraulic simulation is not an end result, but only serves to provide essential variables to calculate an index to physical habitat ("Weighted Usable Area"). Decision-making in physical habitat evaluation with PHABSIM model ("Physical Habitat Simulation System") is based on this index, not on the predicted velocities, and what is

perceived as acceptable error in the habitat simulation doesn't necessarily correspond to acceptable error in the hydraulic simulation. The scope of this work is to explore the way that errors in hydraulic modelling may become errors in habitat during the habitat modelling. Separately analyzed are the contribution of Water Surface Level (WSL) simulation errors and velocity simulation errors to the total modelling error, so that the convenience of a certain procedure for hydraulic simulation can be judged. The field data base consists of 60 cross sections that represents three basic habitats (riffle, run, and pool) in three typical streams (high/medium/low-gradient) of California (USA). The results indicate that the simulation of the aquatic habitat is sensitive to the hydraulic simulation procedure. The calculation of WUA is notably influenced by errors in WSL simulation. Conversely, WUA is not very sensitive to the errors in velocity simulation. The combined effect of these findings show that it is possible to achieve acceptable estimates of the PHABSIM aquatic habitat in projects of ecological restoration of rivers, using measurements of at least three WSLs and one velocity profile.

Keywords: hydraulic modelling, aquatic habitat, PHABSIM, habitat simulation.

Environmental flows setting in Mandeo River (La Coruña, Spain) using the instream flow incremental methodology (IFIM)

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This work aims to develop the guidelines to determine the environmental flow regime in the river Mandeo (La Coruña, Spain), in the bypassed reach from the diversion dam to the restitution point of the Mandeo-Zarzo Powerhouse. This initiative arises due to the necessity to harmonize the hydroelectric generation with the preservation of the aquatic ecosystem, and it is the result of the application of the well-known IFIM methodology ("Instream Incremental Flow Methodology") to evaluate the effect of flow modifications on the fluvial habitat. Morphological and hydrological parameters have been analyzed jointly, as well as the biological ones included through the Habitat Suitability Criteria of the target species. Three representative reaches have been selected, containing a total of 14 cross sections, in which two Water Surface Level and one complete velocity distribution have been collected, in order to create the decisive relationship between the discharge and an index for habitat suitability using the software RHABSIM. The analysis of the time series of habitat created with different alternatives has allowed setting the Instream Flow recommendations with scientifically basis, with defined ranges of flows specified for the different periods of the year, including controlled ordinary floods to maintain an acceptable interaction with the riverine processes.

Keywords: IFIM, PHABSIM, instream flow, habitat.

Forest restoration in a trace elements-polluted area: the case of the Guadiamar River valley

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After a huge mine spill happened in 1998, different programs were developed in the Guadiamar River valley in order to control pollution levels and restore the damaged ecosystems in the affected area. As part of the ecological restoration program, riparian and Mediterranean forest woody species were planted throughout the ca. 2700 ha in the Guadiamar flood plain. A monitoring assessment of these newly planted trees and shrubs has been carried out for this study. A total of 190 plants were selected and marked in 2003, they were distributed among eight stands within the Guadiamar floodplain (six spill-affected and two controls); survival and growth were periodically assessed. Leaf chlorophyll (estimated by a SPAD-meter) and trace elements concentration were also measured. Riparian species, like *Populus alba*, had high survival and relative growth rate (RGR), while Mediterranean forest species, like *Quercus ilex* subsp. *ballota* and *Ceratonia siliqua,* showed the highest levels of mortality during the period of study. For some species, like *Q. ilex*, the RGR was positively correlated with leaf SPAD values. Trace elements concentrations in leaves of the different woody species were within the range of normal levels for plants, with exception of *Salix atrocinerea* and *Populus alba*, which accumulated relatively high amount of Cd and Zn. In addition, the response of tree and shrub seedlings to the residual pollution is been experimentally studied, both in field and controlled conditions.

Keywords: Mediterranean forest, mine spill, *Quercus ilex*, *Populus alba*, cadmium, zinc.

The ecological restoration of system of the water protection zones of the small rivers in city territory

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The reduction of the natural areas of a feed, reduction of speeds and charges of a stream on channels of many small rivers have resulted to the muddying and to the bogging of the water-currents. The updating by underground waters of the river Svisloch' practically does not render positive influence on the small rivers of city. The pollution enter in the rivers with superficial and underground discharge. The existing system of dump of a storm discharge in the channels of the small rivers when impossibility of supply of sanitary - ecological requirements to its quality practically has transformed a river network into transport system of the storm water sewage system. However many of the kept small rivers with adjoining to them territories continue to remain unique natural objects, an ornament of city, its ecological skeleton and have unclaimed to the full recreational potential. The expediency of rehabilitation of river valleys is defined of a degree of safety of natural potential and transformation of water objects. If as a result of rehabilitation actions the discharge of the river will increase considerably it may be as argument at decision making about restoration not only valleys, but also the channel. The organization of water-protection zones of the rivers and the ponds and realization of a complex of nature protection actions in their territories should provide the following factors: the improvement of hydrological and hydrochemical modes of superficial waters; the improvement of qualitative structure of underground waters drained by river network; the reduction of water and wind erosion of the soil; the reduction of abrasion of a coastal zone. The asphalting of the significant areas in added on rivers zones, creation of networks of the storm water sewage system coherented (connected) with the rivers and in result, reduction of volumes infiltration of the atmospheric waters in the first from a surface water-holding horizon have. resulted in increase of a share of superficial waters in a feed of the small rivers in territory of city. It has essentially changed of the character of a seasonal mode of a discharge of the small rivers. For a discharge of the small rivers has become of the sharp short-term fluctuations of the level connected to loss of precipitation are characteristic. The increasing of a share of the superficial waters in a feedstock of the rivers has entailed receipt with them of significant volumes of the polluting substances which are washed off from a surface (mainly the means used for struggle against ice, and mineral oil). In a paper was submitted the results of research of speeds of migration unsorbed pollution (Cl-, NO3-) depending (from) of hydro-geological conditions in the city.

Keywords: Minsk, small rivers, water-protection zones, discharge of

Regeneration establishment 30 years after experimental thinning of Norway spruce plantation

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Natural mixed beech-spruce stands in the lower forest belt of Karkonosze Mountain were replaced by conifer plantations with forest management. These man-created spruce monocultures had a low tolerance to air pollution stress, storms and insects outbreaks, which lead to large-scale diebacks in the 1980's. The resilience of remaining spruce plantations is very low, due to low regeneration, caused by shading by a dense tree canopy. The main management goals are to improve the resilience by supporting tree regeneration and to convert pure stands into mixed stands with broad-leaved trees. The main question is how to manage canopy density to optimise light condition for mixed regeneration. The experimental thinning was applied to the 50 year old pure spruce stand in the in the 1971. On the 3 adjacent plots, 0.25 ha each, different tress density were obtained. Thirty years after experimental thinning the difference in stand structure and below canopy light condition was still evident. The dominant species taking part in the regeneration was Norway spruce, and birch. Only single individuals of other species, like beech were found. The thinning intensity has a significant effect on the regeneration density and seedling and sapling growth rate, but do not increase broad-leaved tree regeneration. The thinning could be used as a management method for resilience improvement of pure Norway spruce monoculture, but do not for creation of mixed stands.

Keywords: Forest, resilience, regeneration, canopy density.

Optimising Tree Seedling Establishment in Riparian Areas in South Eastern Australia

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Riparian vegetation communities in Australia have been degraded by various activities including vegetation clearing, changes in hydrological regimes, and the introduction of exotic weed species. Restoration programs in riparian areas may involve either replanting of key species or enhancing natural regeneration processes, with weed management undertaken to aid seedling establishment. A survey of natural tree recruitment and weed cover at 35 riparian sites in south eastern Australia highlighted the importance of bare ground in providing recruitment niches for tree seedlings. To quantify the amount of bare ground required for successful tree seedling establishment, a trial was established in October 2004 at riparian sites with a continuous canopy of one of two key weed species: blue periwinkle (*Vinca major*) or blackberry (*Rubus fruticosus* agg.). Circular plots of 0, 40, 80, and 120 cm diameter were cleared in the weed canopy and planted with small seedlings of the common native riparian tree species, manna gum (*Eucalyptus viminalis*) and blackwood (*Acacia melanoxylon*). Seedling survival and height growth were monitored. The weeds had a greater impact on survival of manna gum seedlings than blackwood seedlings, with no manna gum seedlings surviving in the uncleared (0 cm) plots five months after planting. Seedling height for both species was greater in the blue periwinkle plots than in the blackberry plots, and the height of blackwood seedlings increased with increasing plot size. Results of this project will assist in the development of appropriate weed management strategies to optimise tree seedling establishment in riparian restoration programs.

Keywords: Riparian, weeds, native trees, seedling establishment.

The potential of phytogenic mounds (nebkhas) for rehabilitation of degraded arid ecosystems

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Wind erosion is the principal mechanism of desertification in many arid and semi-arid regions of the world. In these regions, several native plant species naturally fix windblown materials in small, stable, phytogenic mounds or 'nebkhas', but none of them are currently used to combat desertification. In the Mediterranean-arid ecosystem of Sinai, we screen a variety of such species, not only for sand stabilisation, but also to promote biodiversity by creating habitats for other species, since nebkhas locally improve soil fertility and water status. We explore the potential of a new, natural rehabilitation technique to control the leakage of scarce resources from degraded arid landscapes. We also present evidence that, depending on human impact and landscape, nebkhas can trigger long-term changes in these ecosystems.

Keywords: arid landscapes, biodiversity, native plant species.

Assessment of water quality of the potable water treatment station and wastewater of Suez oil processing company

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Samples used to determine nutrients were immediately treated with 0.5% chloroform as preservative agent, then samples were filtered and the dissolved inorganic nutrients were analyzed using (Metertek SP- 830 UV spectrophotometer). While,all the anions were measured using Ion chromatography(DX-120) using Dionex ion pac-AS14. The data obtained indicated that the level of chemical parameters measured In the effluents were higher than those reported in the inflow water of the Suez oil processing Company, which may be related to the discharge of the industrial wastewater of that company. Also, the drain water of that company was characterized with high level of organic contamination which represented by COD and BOD values 1825ppmAnd 261.8 ppm respectively.This in addition to high turbidity value of 92 NTU recorded in the effluents of that company which is not suitable for the biota of Suez Bay. On the other hand, The seasonal variation of fluoride contents are changed from nil value to 0.39 ppm at loca-

tions 4and 1 during autumn and spring respectively as given in table (1) This may be related to the decay of death organisms in raw water beside, the discharge of domestic sewage of villages into that source of water (dietary) It was noticed that the concentration of turbidity, phosphate,nitrate,nitrite,total hardness,ammonia and acetate in the final treated water were lower than those recorded in the raw fresh water canal which considered as a good indicator for purification of drinking water. Maximum nitrate content was 7.8 ppm at location 1 in autumn and minimum one was 0.11 ppm which scored at location 4 in spring this can probably due to the unexpected increase in the phytoplankton biomass during autumn at the inlet location as the result of the disposal of agricultural wastewater directly into the fresh water canal without treatment it. Which represents the serious problem for the water quality where it is changed during that period (odour and taste).

Keywords: potable water, phosphate, nitrate, nitrite, total hardness, ammonia, acetate.

Use of USLE for predicting soil loss and determining conservation precties in an agricultural wareshed latin capital letter codigo (0130)

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The Universal Soil Loss Equation (USLE) is an erosion model to estimate average soil loss that would generally result from splash, sheet, and rill erosion from agricultural plots. Recently use of USLE has been extended as a useful tool predicting soil losses and planning control practices in agricultural watersheds due to the effective integration of the GIS-based procedures to estimate the factor values in a grid cell basis. This study was performed in the Kazan Watershed located in the centre of Anatolia, Turkey to make conservation planning of the site. Rain Erosivity (R), Soil Erodibility (K), and cover management factor (C) values of the model were calculated from erosivity map, soil map, and land use map of Turkey, respectively R values were site specifically corrected using DEM and climatologically data. The topography and hydrology effects on the soil loss were characterized by LS factor evaluated by the flow accumulation tool using DEM and other watershed delineation techniques in ArcView 3.2. From resulting soil loss map of the watershed, erosion-prone areas were locate and restoration practices were recommended according to the particular requirements of each map units.

Keywords: Soil Loss Equation (USLE), GIS.

Collective identifications and civic participation as key factors for cultural and social resilience in processes of environmental restoration. The case of the Green Corridor in the basin of Guadiamar River

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Our paper comes from the experience of the process of participatory research that we are developing in the basin of the Guadiamar river, called “Participatory Research in the Green Corridor of Guadiamar”, first inside the Research Plan on the Green Corridor of the Guadiamar River (PICOVER) and at present time called “Monitoring Social Participation in the Green Corridor”, inside the Program of Monitoring of this new declared protected space (SECOVER), both they supported by the Department of Environment of the Junta of Andalusia. We will present the objectives, methodology, development and results to the present of our work, and we will reflect on the fundamental role that the active participation of the citizens has in the plans of recuperation and restoration of spaces, so as on the need to get it, not only of a sincere and generous political will on the part of the administrations and the technicians, but also of media, instruments and methodologies to do it adequately. In this sense we insist on the importance of the articulation and identification with the territory of the local population and their intangible cultural resources as factors of social resilience and for the effective people’s implication in the environmental restorations.

Keywords: participation, collective identifications, cultural and social resilience, Participatory Action Research.

Restorating nature in coastal arid lands of Northwestn Mexico: a story of failure

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Restoration is a story of trial and error and learning restoration is more error than trial. We found that reading restoration journals can send the message that restoration is full of successes and easy tasks. Unfortunately, very little is published about failure so we cannot learn from errors. In developing countries is worst: volunteers are not available, permanent plots (scientific field stations or really protected areas) are inexistent and impossible to acquire and/or keep for long lasting experiments, patience to wait the results of natural recuperation or restoration techniques is threaten by smaller budgets and short scope of scientific research agencies aims. In this paper we present three examples, of different failure proportions, in the arid coastal area of Baja California, Mexico. 1) Coastal sand dunes restoration experiments: germination and establishment of the key species (*Abronia maritima*), 2) Coastal sage scrub recuperation of large patches after fire, cutting and/or grazing, and 3) Definition of the original "natural" state of a coastal site for restoration and educational purposes. We propose a website to publish failure in order to learn from it.

Keywords: restoration, arid land, *Abronia maritima.*

Dynamics of vegetation in restored slopes from mining activities in central Spain as conditioned by different levels of water erosion

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In Mediterranean environments, the failure of restoration projects from mining activities is mainly provoked by water deficit, since it reduces the possibilities of colonisation and establishment of vegetation. The aim of this work is to analyse the dynamics of vegetation in three artificial slopes subjected to different levels of water erosion in a restored open cast mining area in Teruel, with a continental Mediterranean climate. Our hypothesis is that water erosion affects vegetation dynamics by reducing the low water availability of these environments. During 2003-2004 growing season, we studied the composition of the soil seed banks, seedling emergence and survival, leaf area index and seed production in the three slopes. All these parameters were negatively affected by water erosion, that, through the development of rill networks, also reduced soil moisture content. Besides, we have identified several key processes that condition the successful establishment of vegetation in these environments. We conclude that water erosion and vegetation development are two processes that are interconnected by a feedback mechanism which needs further experimentation in order to improve the success of restoration practices.

Keywords: Mediterranean environment, open cast mining restoration, seedling emergence and survival, vegetation dynamics, water erosion.

Restoration of degraded Mangrove by participatory approach: a pilot initiative

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Chokoria Sundarbans - one of the oldest mangrove forest in the Southeast Asia have been degraded and converted due to anthropogenic factor particularly for shrimp culture. Under the prevailing condition, IUCN Bangladesh has taken initiatives to motivate the local community particularly the shrimp farmer and to restore the degraded forest at a pilot scale. UNEP/GPA funded the pilot activity to initiate some sort of restoration activity of the critically degraded ecosystem at Chokoria Sundarban. The overall objective of this program was to restore and rehabilitate the degraded mangrove ecosystem of Chokoria Sundarban on a pilot scale with community initiatives and to initiate a sustainable management regime. Community based approach was followed in the implementation of the programme that integrates restoration of natural forest and restoration of human needs to strengthen the fundamental connection between economic prosperity and environmental well being of the people. This approach provides a framework drawing together all relevant stakeholders. Considering the experience of others success stories and failure in rehabilitation, it was tried to involve the community as much as possible, so that the community realize their ownership on the programme and the whole system become transparent to all. Area specific rehabilitation plan has been prepared with the involvement of local community considering the existing biophysical and socio-economic conditions of the site. The entire activity was planned and implemented on a participatory basis, and involve all local resource users and stakeholders through transparent community-based planning, implementation and monitoring. Through this pilot initiative, 21 hectares of degraded and newly ac-

creted land have been restored with mangrove species. For sustainable management of the restored site a rehabilitation and advisory committee was formed with representatives from community, shrimp farmers, local govt. body, civil society, etc. Neighboring peoples within the Chokoria Sundarban are eager to replicate this in their respective localities. However, for sustainability of the efforts, continuous observation and some sorts of livelihood promotion package will be incorporated within the programme framework in next phase. It is expected that the success of these community-based interventions will lead to the replication of this approach in other areas across earlier Chokoria Sundarbans.

Keywords: Chokoria Sundarban, Mangrove, Shrimp farming, Participatory approach, Community based restoration.

Reference dynamics: using reconstruction of ecological processes to restore natural variability

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Restoration practice and research seek reference conditions in a variety of compositional, structural, and functional elements. We propose a "process-centered" framework that places central emphasis on ecological functions and ecosystem processes. What distinguishes a process-centered restoration (PCR) approach is not simply the inclusion of ecological processes in the restoration design but their centrality, and the resulting emphasis on spatial and temporal variability. In a PCR, ecological processes, structure and composition covary as they do in nature, beginning by defining the natural range of variability for the process of interest. For example, in many forests and woodlands, fire is a keystone ecological process that interacts dynamically with forest composition and structure. Fire also mediates the governing effect of climate on temporal variability in ecosystem function, as a number of studies in the region have documented. We illustrate this approach using a 450-yr reconstruction of the natural surface fire regime in a Ponderosa pine forest in the Jemez Mountains of southwestern North America. Fire occurrence varied over space and time during the period of record, with ecologically significant variation in fire intervals (yr $fire^{-1}$). Temporal variation in fire occurrence appears to be entrained by fuel dynamics and high-frequency climate variation, such as the El Niño Southern Oscillation (ENSO), as well as decadal variability governed by the Pacific Decadal Oscillation (PDO) and the Atlantic Multidecadal Oscillation (AMO). Multiscale analysis indicates that the fire regime is a scale-dependent property, with mean fire intervals ranging from 18 yr for 4-ha sample windows to 3 yr for 250-ha composites. We propose that a "reference dynamics" paradigm replace the more static concept of "reference conditions" in defining restoration baselines and the governing factors such as climate that influence both natural and restored ecosystems.

Keywords: fire regime, process-centered restoration, spatial and temporal variability, ecosystem processes, disturbance, fire-climate relationship.

Restoration of Coral Reefs Using Transplantation of Cultured Corals

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In most cases, coral reef restoration has used corals collected from the field. However, the degradation of coral reef has occurred world-wide and the collection of reef corals from the field puts a negative impact on coral reef. Mass coral culture by asexual propagation of corals provides an alternative source of promising and sustainable supply. Many coral species including branching corals (*Acropora yongei, Montipora stellata, Montipora digitata, Stylophora pistillata, Pocillopora damicornis, Heliopora coerulea*), massive corals (*Porites lutea* and Faviids), and foliaceous corals (*Montipora aequituberculata, Montipora foliosa, Merulina ampliata*) have successfully propagated asexually in National Museum of Marine Biology and Aquarium, Taiwan. They were cultured by tying 5 to 10 fragments (about 2 cm in length) in a nylon string and hanged in coral reef mesocosms. A total of 180 cultured corals (>5 cm in diameter) were attached to cement substratum, transported by car and boat to the artificial reef (piles of abandoned concrete rods) at Hsiaoliuchiu, Taiwan. Corals were cemented to concrete rods at the depth of 20 to 25 m using epoxy and nylon cable ties. This method of tying corals was effective and increased the working efficiency at deep water. The survival rate was 100% after 2 month transplantation that indicated initial success. The transplantation of cultured corals could replace the corals collected from the wild and greatly promote conservation and restoration of coral reef.

Keywords: Artificial reef, restoration, coral reefs, transplantation, cultured corals.

The Brazilian coastline environment restoration - a case study at the northeast coast of Brazil

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The coastal zone always concentrated diverse activities and uses. In this perspective the present study aims at analyzing the littoral environment, with emphasis on the beach zone, by an integrated analysis of its physical-natural and socio-economic elements. The study compares areas of human influence in the shoreline, where it causes the process of erosion of the shoreline, with places without any human influence. The study was carried out in behalf of the city of Tamandaré, State of Pernambuco, northeast of Brazil. The coast of Tamandaré is characterized by diverse ecosystems: coral reefs, mangroves, dunes and beaches. This was achieved through the analysis of data consisting of the number of summer houses and hotels and data of their location, as well as the analysis of the topographical and sedimentological profiles. Thus, it could be observed observe that at the places where the influence of human beings could be recognized, who increase the process of sea erosion, which characterizes the disequilibrium in the sedimentary zone, destroys also houses and streets, as well as generates various other problems. In the area where there are no houses or any other building it is observed that the beach is always in balance. In these areas there is no problem in the sedimentary balance, which is always well regulated, as well as does not exist any disturbance of the coastal vegetation and the dune fields. By this means it was possible to verify the importance preserve and protect the coastal environment including the beach zone.

Keywords: Coastline, restoration, erosion, beach, shoreline.

Salt-land ecology: leaf litter and recruitment

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Agriculture in the low-rainfall (< 250 mm) region of Western Australia is threatened by secondary dryland salinity. Sustainable solutions must find balance between land use activities that halt salinisation, while also contributing to farm productivity. The present study examines the importance of leaf-litter driven recruitment to the sustainability of a salt-affected agricultural site. The site consists of two perennial vegetation components: *Eucalyptus sargentii* (tree) rows with *Atriplex* species (saltbush) interows. This alley planting provides shelter and fodder for stock; while removing excess water from the system. Arrangement of bare and vegetated rows in this system is similar to natural banding patterns observed in semi-arid areas. Therefore knowledge of recruitment processes in these natural systems can be applied. An experiment was conducted to test whether wind re-distributes litter from open areas to trapping microsites; and whether redistribution varies seasonally with prevailing wind direction. Spray-painted leaves were dropped in open microsites adjacent to the tree row in order to track redistribution. Distance from origin, direction of movement and trap characterisation were measured after one month. Approximately 80% of leaves were recovered in both summer and winter. All recovered leaves were trapped, with the majority in littered vegetation (tree and saltbush) traps. Distribution of leaves was significantly affected by prevailing wind direction. This study quantifies some mechanisms behind observed litter distribution patterns in bare and vegetated areas, where existing vegetation creates traps for leaf-litter. The ongoing process of litter trapping and redistribution creates potentially favourable niches for recruitment; thereby contributing to sustainability of the system.

Keywords: Leaf-litter, salinity, sustainable agriculture and recruitment.

Ecological restoration, carbon sequestration and biodiversity conservation: the experience of SPVS in the Atlantic Forest of Southern Brazil

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Since 1999, SPVS has been involved in three projects that combine two fundamental goals over the course of 40 years: the conservation of one of Brazil's most important remnants of Atlantic Forest and the implementation of projects for carbon sequestration. In addition, there is an interest in replicating these projects in order to restore other degraded areas, protect the Brazilian biomes, and help to diminish deforestation and forest fire, therefore reducing carbon emissions. The acquisition of 19,000 hectares of degraded areas of high biological importance in Southern Brazil was the first step towards the implementation of the projects. These areas are owned by SPVS, a Brazilian NGO, and are being restored, con-

served and transformed through Private Natural Reserves, in partnership with the NGO The Nature Conservancy, and financed by the companies American Electric Power, General Motors and ChevronTexaco. The process of forest restoration involves several stages: soil studies, surveying the region's native plants, planning for restoration by means of a Geografical Information System, production of seedlings, application of different techniques for planting (such as manual or mechanized planting with seedlings and stakes), and biomass and biodiversity monitoring. To guarantee the survival of the seedlings on the planted areas, there is a permanent maintenance program including weeding of undergrowth, crowing and organic fertilization. The projects are testing and developing methodologies to restore waterlogged areas. The three projects already planted around 450,000 seedlings of native species until December 2004, and aims to plant more 1,000.000 until 2009.

Keywords: Restoration, biodiversity, Atlantic Forest, carbon sequestration, Brazil.

Participatory negotiated landuse change at floodplains with multifunctional use at Bodrogköz, Hungary

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Multifunctional use of floodplains has a role in flood risk management, restoration of oxbows, old creeks, water storage and carbon sequestration. It improves the adaptation capacity of the landscape in the light of climate change effects, such as extreme weather events (draught, intensive precipitation, wind erosion) and would support a healthy and wealthy community based on wise resource management, too. Societies of small municipalities at the Tisza region in Hungary are endangered - high unemployment, economic and social problems occur. The society nearly lost the connection to river system: traditional floodplain management techniques (such as notch-management) almost disappeared. In order to solve these problems, the traditional structure of floodplain landscape and its management were analysed and adopted for the present challenges. The complex ecological, social and economic role of specific habitats, such as floodplain forests, traditional orchards were defined. Further on these ideas have been discussed at several local forums. Approval of the municipality councils has been achieved to develop a complex landuse change strategy, based on shallow water inundation for multifunctional purposes. Different partnerships were built with authorities (nature park, water bodies) and research institutes as well. Based on landscape assessment the present activities were visualised for general public as well. Special complex 1D-2D hydraulic, hydrodynamic model was developed to serve as a tool for iteration with the land users and landowners. At specific sites joint action of all relevant stakeholders lead to a harmonised, participatory negotiated landuse in the light of the national Vásárhelyi Flood risk program.

Keywords: participatory negotiated landuse, multifunctional floodplain, 1D-2D modelling, landscape assessment based visualization, habitats role in landscape.

Outline of the main themes of Road Ecology

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The coalescence of road-ecology science, when combined with engineering and planning, promises a future where safe and efficient human mobility is effectively combined with natural processes and biological diversity. Six research areas are of major direct policy importance. (1) Wildlife populations and biodiversity are significantly affected by landscape fragmentation related to roads. (2) Traffic noise/disturbance creates a wide zone avoided by sensitive birds and other species, which is of reduced value for nature conservation. (3) The huge total area devoted to roadsides contains invasive species and yet-to-be-surveyed rare species, an area for which an appropriate vegetation cover could serve many societal values. (4) A cornucopia of pollutants is swept by wind and washed by rainwater into streams, lakes and other water bodies, where aquatic ecosystems are degraded. (5) The road-effect zone over which ecological effects are significant, integrates the engineer's and ecologist's perspectives as a basis for transportation planning. (6) The form of the road network in a landscape is a keystone for overall ecological conditions, for planning road construction and removal, and for sustainable transportation for society. However, these latter expectations are still far from realization. Currently, actions are limited to site reclamation protocols based on agricultural principles. Roadside ecological singularity should frame, but not exclude, the ecological restoration approach. In this emergent scenario, connectivity with remnant cells, colonization, recruitment, interaction among organisms, and population dynamics should be revis-

ited. This reappraisal should not simply involve the revision of technical protocols, but mainly the redefinition of success in roadscape design.

Keywords: roadside ecological restoration, engineering and planning, research areas, road-ecology science.

ALTER-Net and the challenge of a European network for long-term ecological research

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ALTER-Net is a Network of Excellence project under the European Union's 6th Framework Programme for research. It has 24 partners under coordination of the Centre for Ecology and Hydrology, UK. ALTER-Net's overall purpose is to develop lasting integration between key research institutions in Europe to address the research needed to understand how biodiversity changes under natural dynamics and human influences at the European level. A key component of ALTER-Net's work programme is to develop a framework for a site-based European long-term ecological research network as a basic tool to address critical biodiversity research questions. ALTER-Net looks at biodiversity research within the DPSIR framework, in a comprehensive approach to the Drivers and Pressures affecting biodiversity, the States and Impacts on biodiversity components, and the human Responses to biodiversity change. A biodiversity research network should be able to cover all these components. This implies that such a network must have sites covering a range of spatial scales, ecosystems and human influences on biodiversity, including both environmental and socio-economic approaches. By representing a long-lasting research infrastructure and covering the range from pristine to heavily affected ecosystems, such a research network may provide an effective framework for research on restoration ecology. The properties of the various sites may reflect gradients in recovery useful in analyses of restoration processes ('space for time'), pristine sites may function as models for baseline or reference states, and the long-term perspective may allow long-term, multi-site experiments of various models for adaptive restoration management.

Keywords: Ecosystems, biodiversity, long-term research, network of sites.

Soil formation and carbon sequestration in reclaimed and non reclaimed post mining sites the role of vegetation and soil biota

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Soil formation is important step in ecosystem reconstruction in heavy disturbed areas. Two chronosequences (spontaneous succession and forest reclamation), were studied in alkaline clay substrate after brow coal minnig near Sokolov (Czech Republic). The spontaneous plots develops towards woodlands (*Salix caprea, Populus tremuloides* and *Betula* spp.) Reclaimed sites were planted by alder (*Alnus glutinosa* and *A. incana*). Rate of C sequestration was similar in both chronosequences (92-102g m^{-2} $year^{-1}$), in reclaimed sites soil C stock increased rapidly in younger plots and slow down latter opposite pattern was found in spontaneous sites. Field microcosms experiment, indicated that soil macrofauna did not increase C mineralization but enhance C accumulation in mineral soil, this effect was more pronounced in reclaimed sites. Laboratory microcosms colonized by various guild of soil biota show that fauna mediated litter removal in spontaneous sites correlated with the accumulation of C in mineral layer and with C mineralization in reclaimed sites. Soil macrofauna was more abundant in reclaimed sites which result in more intensive litter fragmentation and soil mixing in reclaimed sites. In spontaneous sites macrofauna activity was much less pronounced, however increase in earthworm density in the oldest spontaneous plots resulted in rapid formation of humus layer. Hardly decomposable litter in spontaneous sites may enhance C sequestration in latter succession stages. Study indicate that vegetation affect soil formation is complex and include also indirect effects mediated by soil biota.

Keywords: restoration, coal mining, soil development, soil biota.

Fire Regime in a Conservation Reserve, Chihuahua, México.

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Fire regime characteristics were reconstructed from fire-scarred trees in the Tutuaca reserve, a newly designated protected area in the Sierra Madre Occidental of western Chihuahua. The reserve was created to protect thick-billed parrot nesting habitat (large snags) and a relict forest of Chihuahua spruce (*Picea chihuahuana*). We collected fire-scarred samples from conifers (*Pinus ayacahuite*, *P. durangensis*, and *Pseudotsuga menziesii*) in three 25-ha sites arrayed at different watershed positions, from a low site adjacent to the spruce trees up to the watershed divide. Fire analysis periods began in 1702, 1704, or 1761 and continued through the final fire in 1955 (two sites) or 1995. All sites had frequent fire regimes (Mean Fire Interval [MFI] 3.9-5.2 years; MFI for years in which 25% or more of the samples were scarred: 6.9-8.4 years). Almost all fires occurred before cambial growth began or early during the season of cambial growth. Fire years were significantly dry and the years immediately preceding fire were significantly wet. After 1955, no further fires occurred at two of the three study sites, a pattern similar to that observed elsewhere in northern Mexico. The third site had fires in 1987 and 1995. The extended fire-free period in portions of the Tutuaca landscape may result in fuel accumulation and eventually in severe wildfire. For effective conservation of fire-susceptible habitat features, managers should seek to incorporate surface fire as a tool for active restoration.

Keywords: Pine-oak forest, Sierra Madre Occidental, *Rhynchopsitta pachyrhyncha*, fire scars, dendrochronology.

Metaphors of Restoration: Combining insights from the life and earth sciences with the humanities

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The Andrews Forest ecosystem research group and the Spring Creek Project for Ideas, Nature, and the Written Word are collaborating in a program that brings creative writers, humanists, and ecosystem scientists together at the Andrews and in other natural venues in the Pacific Northwest. Our first event explored “Metaphors of Restoration” to discover how we think about our restoration efforts and how we can better communicate. Bringing scientists together with writers and musicians was fruitful and launched a program of Long-Term Ecological *Reflections*, to complement our Long Term Ecological Research program at the Andrews, supporting writers and humanists in their efforts to explore human/nature relationships as they evolve over time. The program and some of its best products to date will be presented.

Keywords: Metaphors, creative writing, ecological reflections, long-term, communications.

Stream simulation as an approach to the design of road-stream crossings to avoid lotic habitat fragmentation

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Culverted road-steam crossings traditionally have been designed for hydraulic efficiency. Unfortunately, hydraulically efficient road crossings often create barriers to aquatic organism passage by interrupting the continuum of stream form and process. There are hundreds of thousands or millions of culverts installed on streams that impede access to habitat essential for the viability and survival of aquatic biota. The mechanisms for habitat fragmentation by culverts include excessive velocity of flow, inadequate depth, and perching of the outlet creating an insurmountable jump. The US Forest Service has developed systematic guidance for a new approach to designing bridges and culverts, called “stream simulation” that strives for minimum intervention in stream geomorphic process. The principles of this design approach and alternative approaches will be described.

Keywords: Lotic systems, fragmentation, fish passage, culverts, stream simulation, aquatic organisms.

Integrated restoration and management of a cultural and natural heritage site : 13 years of ecological studies in the Megalithic Site of Carnac (Brittany, Western France)

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This paper aims at presenting how front of a dramatic situation of degradation and lack of management, an integrated approach of ecological restoration and management had been conducted in the Megalithic site of Carnac during the last 13 years. This classified historical monument site is known worldwide for its lines of more than 2500 standing stones Nevertheless, until 1991 the site was freely accessible to the public and mostly unmanaged. During the 1980s, tourist pressure increased rapidly and concentrated both in time (during summer) and in space (around larger stones). This led to very important degradations (4 ha of naked soil, uncontrolled thicket on other part). Faced with this situation, the decision was taken, in 1991 to close and to restore the site. The restoration consisted mainly in the restoration of a vegetation cover which would protect the soil from further erosion.. Restoration was included in a larger process about this site master planning (access, reception of the public, etc). Between 1991 and 2001, vegetation monitoring, observations , mappings and experimentations were conducted within the site, financed by the Ministry of Culture (owner and manager of the site). All the acquired knowledge (scientifically validated by publications and PhD thesis) as well as an assessment of the past 10 years management were used to build management prescriptions which were redacted in 2002 as a management plan for the vegetation of the site. It integrates the preservation of restoration processes, vegetation development control and integrates possibilities of tourist frequentation. It is adapted to site characteristics and particularly takes into account vegetation heterogeneity by defining management unities within the site. It also take into account the available management means (men, herd and materials) and the local context. This management plan is a dynamic plan which gives bases for management decisions that have to be taken each year according notably to vegetation state.We can now consider that the main initial objectives are reached as most of the vegetation fit with the defined ecosystem of reference.The sustainability of the restoration will now depend on long term application of ecological management and on political decision concerning the global planning of the site.This management experiment with its difficulties and success is a strong illustration of the importance of an integrated (human, economical and natural) approach and analyse of a site for the realisation of an integrated management plan in a conservative view.

Keywords: ecological restoration, reference ecosystem, integrate management plan.

Restoration of *Pinus pinea L.* habitat in Strofilia forest, southern Greece (Life Project 2002/Nat/GR/8491)

Ganatsas P.

The *Pinus pinea* L. forest of Strofilia is located in the western Peleponnesos, southern Greece. The forest belongs to a wider system of costal dunes and wetlands that are included in the RAMSAR convention and the Natura 2000 European network. All the area is subjected to high touristic pressure; overgrazing also contributes to *Pinus pinea* habitat deterioration. The forest is characterized by the absence of natural regeneration for many decades (since 1954), and this seems to contribute to a forest succession and the gradual replacement of *Pinus pinea* by the species *Pinus halepensis*. However, this has been resulted in the restriction of *Pinus pinea* biotope in the area. Twenty permanent plots were established in the area where twelve treatments were applied in order to investigate the reasons for the regeneration absence of *Pinus pinea* and to restore the species habitat. The treatments were distinguished into two categories: I) treatments aiming at the seedling establishment, applied where natural regeneration of *Pinus Pinea* was absent, and II) treatments aiming at seedling growth, applied on some areas where seedling establishment had been already naturally started. The treatments of the first category were: 1) fencing, in order to exclude grazing effect, 2) seeding felling to canopy cover 50%, 3) seeding felling to canopy cover 30-40%, 4) removal of *Pinus halepensis* trees, 5) shrubstory removal, 6) subsoiling, 7) seeding in patches, 8) planting of one year old seedlings of *Pinus pinea* and 9) control plots. The treatments of the second category were: 1) fencing, 2) secondary (release) felling, 3) understory (herb layer) removal, 4) cultivation of seedlings and 5) control plots. All the treatments were applied in subplots of 0.15 hectares that were systematically arranged within the plots. At least three replications in three different plots were applied for each treatment while a buffer zone of 15 m width was left between the treatments. Stand conditions were recorded in details before treatment

application as well as the natural regeneration of *Pinus pinea*. Monitoring of the influence of treatments on stand and site conditions as well on natural regeneration of *Pinus pinea* will be carried out for the next two years. However, first results will be available during the spring of 2005.

Keywords: Stone pine, natural regeneration, forest succession.

Fish passage at road culverts: monitoring, analysis and design

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The actual concept of fish passage barrier is linked not only to the presence of dams, weirs and natural obstructions that block passage to upstream habitat but to those particular situations in which local hydraulic conditions (velocity, depth, turbulence...) are beyond the swim capability or the biological requirements of fish species. These are common situations in culverts and drainage structures frequently used as road crossings. Fish passage at road culverts is becoming an increasingly important challenge in aquatic habitat improvement and conservation schemes. Because of their characteristics, these drainage structures represent a very attractive low-cost structural solution for road crossings, and their rapid proliferation is a common phenomenon in both developed and underdeveloped countries. This paper review fish passage problems commonly found in culverts and explains the different methods outlining a crossing analysis and tools available for improving culvert design to accommodate fish passage, with an special insight into FishXing 3.0, the new released version of this freeware fish passage culvert analysis program that nowadays constitutes the most complete and reliable software available for fish passage analysis and design at culverts.

Keywords: fish passage, program, culvert.

Tidal salt marsh restoration in Guadalquivir River Estuary (SW Spain)

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The sediments from dredging a navigation channel in River Guadalquivir in 1985 were deposited in the Estuary banks over a band of tidal marsh about 200 m wide and 2 Km long. The Ministry of Environment started the restoration of a sector of 52 ha of Algaida Marsh that belongs to the Natural Park of Doñana. The ecological restoration project was designed by the Department of Plant Biology and Ecology of Seville University and has been implemented during 2000. The ultimate goal of Algaida Marshes restoration has been to reestablish the ecological processes, functions, and as a consequence to recover former diversity. To this objective the original habitats (water regime, sbstrates), were reconstructed; the dispersion vias to the habitats were provided and the tidal flow to the surface, was reinstalled. The restoration was accomplished in four steps: 1) removal of dredged material from the fill, 2) geomorphologic reconstruction, and 3) restoration of tidal flow; with two intervention levels. In N sector a high intervention level with an intense remodeling action to build a mosaic of diverse habitats. In the S sector a low intervention level just inducing the geomorphological processes that will reconstruct the tidal marsh in an example of self-design application. To evaluate design and intervention levels and to estimate integration of restored area with the surrounding Doñana Natural Park, a monitoring program has been incorporated, covering vegetation, fauna and geomorphology.

Keywords: restoration, salt marsh, self-design.

The restoration of El Partido stream watershed (Doñana Natural Park). A multiscale, interdisciplinary approach.

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Some 2300 ha of the watershed of El Partido stream belong to Doñana Natural Park. During heavy precipitations a sandy depositional delta is building on Doñana Marsh, now extending for 300 ha. Under Doñana 2005 Restoration Project, El Partido stream will be diverted to spread over some 1500 ha in order to prevent further sand transport.The ecological restoration of the spread surface, includes: build-

ing a hydraulic scheme favouring sand deposition avoiding its transfer to the Marsh; recovering menaced aquatic habitats and the former natural regime of surface waters; restoring some of the original ecosystems of the area; creating functional ecosystems where lynx and imperial eagle may find suitable hunting ground. A regional vegetation study provided the composition and structure of plant communities and the succession sequences. 850 vegetation patches 20 to 40 m across recreating existing natural patches will be planted. Also screens of tamarisks and poplars will be used along channels. Each patch combines a core of trees and scrub sectors of fruit bearing (sprouters) and flower bearing (seeders). This will help supporting animal populations that could enhance the expansion of the restored vegetation types in the future. Monitoring of water table, soils, vegetation, vertebrates, aquatic biota and water quality has been in progress. Some experimental patches have been planted and the performance of the species recorded for two years prior to restoration.

Keywords: ecosystem function, hydrology, landscape, multiscale restoration.

Effect of grass treatments on seedling recruitment in the vicinity of isolated trees in tropical pastures

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Rainforest regeneration in tropical pastures is impeded by environmental and biological barriers. Such barriers can be result of exotic grass establishment and propagule scarcity. We studied the effect of four grass treatments on seedling recruitment around four isolated trees in abandoned tropical pastures in Chiapas, Mexico. Trees were separated by at least 3 km, with each tree representing one site. The grass treatments consisted of a) cutting superficial biomass, b) removing all superficial biomass, c) applying herbicide, and d) control. Each treatment intended to eliminate above- or under-ground competition, but with variations in resulting microclimatic conditions. Grass treatments were established randomly in four different distances from the focal tree (5, 10, 20, and 48 m from the trunk). Seedlings of native tree, bush, and liana species were registered every 3 months from October '04 to April '05. Each site showed particular results, indicating that there is a strong site effect. In three of four sites higher seedling proportions were observed 5 m from the focal tree's trunk. Recruitment was up to 8 times lower outside of the canopy. No grass treatment enhanced recruitment considerably. Treatments that completely removed above-ground biomass considerably reduced soil humidity, which in turn impeded seedling establishment. The treatment that did not completely remove above-ground biomass had no significant differences with the control treatment, though it showed the highest overall recruitment. Our results suggest that previous land use (i.e. exotic grass density and fire use) strongly determine the site's regeneration ability when abandoned.

Keywords: rainforest regeneration, tropical pastures, seedling and grass competition, Mexico.

Phosphate mobilization in fen wetlands: the roles of iron, chloride and sulphate

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This study is part of a national research programme that aims to determine key factors for the restoration and management of Dutch fen wetlands, specifically with respect to internal mobilization of nutrients (internal eutrophication), a major problem in Dutch fens after the influx of nutrients has been reduced. First, surface and pore water samples were collected in a broad range of fen wetlands in the Netherlands and abroad. Most Dutch fens showed high concentrations of sulphate and chloride, while iron concentrations were low. Therefore, the roles of iron, chloride and sulphate were tested experimentally to study their effects on phosphate mobilization. Field data show that disturbed fens, with low biodiversity, are characterized by a low iron:phosphate ratio (< 1 mol mol^{-1}) in the pore water, which strongly increases the risk of phosphate mobilization, increasing turbidity of the surface water and the deterioration of submerged vegetation. Only when sulphate concentrations in the surface water remain below 200 µmol L^{-1}, target iron:phosphate ratios (> 10 mol mol^{-1}) can be achieved, because sulphide production remains low. In contrast to other research, we did not find that chloride was able to mobilize phosphate from fen sediments. On the contrary, the supply of chloride to sediments of formerly brackish fen wetlands showed a clear negative effect on phosphate mobilization. We will discuss our results in relation to feasible restoration measures, both for freshwater fens and for formerly brackish fens.

Keywords: phosphate mobilization, biogeochemical interactions, fen wetlands, restoration.

Restoring Biodiversity to Pine Afforestations in Israel

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The management of Israel's planted forests for biological diversity values is a relatively new phenomenon. Globally, awareness of forest biodiversity issues originally centered around the loss of species, populations, their genetic materials and the habitats necessary for nurturing them in natural forest ecosystems threatened by excessive and insensitive human development. Recent research began addressing the question of how to convert simple, monocultural, plantation forestry systems into productive forests with a built-in ability to enhance their biological diversity potential. Israel's situation falls into the latter category. Most, if not all, of her high forests were planted and consist primarily of a small core group of native and exotic Mediterranean conifers and eucalypts, creations of a massive national program to reclaim and restore Israel's degraded Mediterranean landscape. Over time, these simplified afforestations evolved into a complex set of forest stands resulting from three processes: 1) the recolonization of native tree and shrub species into the understory; 2) the diversification of simplified stand structures, due to natural mortality, destructive agents, natural regeneration and the development of patch dynamics; and, 3) mixed-species renewal plantings. A "near-native" type of forest ecosystem is currently evolving, embodying a sum total of natural and artificial processes – a forest which combines elements of pioneer afforestations plantings and a regenerating, native Mediterranean oak maquis. They serve as models to help visualize and understand how plantation-type forests can be converted into complex afforestations systems possessing a higher degree of structural functional, compositional and genetic diversity.

Keywords: restoring biodiversity, oak, Israel.

The role of geosciences and geomorphology in restoration ecology

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Geomorphology can play a key role in restoration ecology. This is due to: (1) the interactions of different rock types and processes will lead to different landforms, soil types, and hydrologic conditions; (2) active geomorphic processes, such as soil erosion, fluvial processes or mass movements affect the dynamics of ecosystems. The understanding of geomorphologic processes is essential in the ecological restoration of degraded areas caused by mining activities or public works such as road building or dam construction. In a Restoration Ecology framework, landform re-shaping considerations should include drainage and runoff control, slope stability, soil formation and visual requirements. It is also necessary to consider the history of landform development since process that built a landform may not be acting on it at present. For example beach and delta deposits of Lake Bonneville (Utah, USA) are now subject to fluvial erosion. In this presentation, we describe the geomorphological design of an ecological restoration of a silica sand strip-mine in Segovia Province of central Spain. The restoration project design was based on a comprehensive analysis of local geomorphic, hydrologic and edaphic conditions. A combination of a computer-aided design from a digital elevation model (DEM), along with a reconstruction of the former geological architecture of the area including an understanding of parent material and surficial deposits, were the main contribution from the geosciences. Ten years of monitoring (1995-2005) of the high-wall and pit-floor has indicated that an ecological restoration design that considered information on local geomorphological parameters and functions, has resulted in self-sustaining hydrological, edaphic and vegetation conditions, which mimic the surrounding native ecosystems.

Keywords: geomorphology, geomorphic processes, landform reconstruction, soil quality, self-sustaining ecosystems, Segovia (Spain).

Ecological conditions of riparian areas in the Guadiana Basin (Upper and Middle Basin, Spain)

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The riparian area conditions of 125 fluvial segments of 75 rivers belonging to the upper and middle parts of the Guadiana Basin have been evaluated, applying a new score system which takes into account the main characteristics of riparian structure and functioning. The absolute and relative values of the applied score system are presented, and the main degradation factors are revised, being all of them related

to agricultural practices. Groundwater abstraction and river channelization in La Mancha area (upper part of Guadiana Basin), and intensive irrigation agriculture associated to flow regulation by dams and irrigation canals in the middle part of Guadiana basin have dramatically reduced the lateral dimensions of riparian areas, the access of floodplain, the regeneration capacity of woody riparian species and the riverbank habitat quality. Ecological restoration is hardly needed in the studied area, and should include the establishment of large riparian buffer strips along the agricultural fields, and the implementation of more sustainable and less water demanding agricultural practices.

Keywords: riparian area, habitat quality, Guadiana Basin.

Evaluating Ecological status of riparian areas: A new index to qualify riparian structure and functions

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The main characteristics of the structure and functioning of riparian areas are analyzed, and a new score index is proposed to qualify their ecological status. Longitudinal continuity of natural riparian woody vegetation; lateral dimensions of riparian area; species composition and structure of riparian vegetation; woody species regeneration; bank stability and habitat quality; access to floodplain; and permeability, substratum and topography of riparian soils are the attributes taken into account. Characteristics corresponding to "very good", "good", "moderate". "poor" and "bad" conditions are defined for each attribute, being integrated in a relatively simple and hydrologically based score system, which allows not only to estimate averaged ecological conditions, but also to identify systematically common problems of riparian areas and formulate basic strategies for their ecological restoration.

Keywords: riparian areas, index, permeability.

Restoration and management of the Palo Verde ramsar wetland, Costa Rica

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During several decades, the Palo Verde seasonal wetland, located within the Palo Verde National Park, Costa Rica, was considered the most important wetland on the Pacific side of Central America due to its ecological role as refugee and feeding site for waterfowl, especially neotropical migrants. Unfortunately, during the last decade, this wetland has severely been threatened by massive invasion of aquatic plants, especially cattails (*Typha dominguensis)*, which dominated almost completely the whole marsh, leaving no open spaces for waterfowl. Through this restoration project we look for the conservation of an International Ramsar site, which was included in the *Montreaux* protocol due to changes on its structure and biological function. The restoration project pretends to rehabilitate over 350 Ha to the condition observed in 1979, year when the maximum number of birds and species were reported. The main objectives of the project were to control and reduce the area dominated by invasive cattails through fangueo (tractors with paddling wheels to crush down cattails) and grazing, to restore the hydrology of the wetland, and to monitor the changes in the vegetation cover and habitat use by aquatic birds. In order to accomplish these objectives, the project team conducted detailed topographic surveys of the marsh, analyzed historical records using aerial photos and satellite images, and developed computer models of the restoration. Even though the project is still under execution, the results are really promising. According to the monitoring, during the dry season of 2003 and 2004, more than 50 species of aquatic birds, both resident and migratory, used the wetland as feeding and refugee site. Thus, near 15,000 individuals of Black-Bellied Whistling-Ducks (*Dendrocygna autumnalis*), 8,500 Blue-Winged Teals (*Anas discors*) and near 200 Fulvous Whistling-Ducks (*Dendrocygna bicolor*) were easily spotted in the marsh, species and individuals reported back in the late seventies. The rehabilitation of the marsh has notably favored the diversity of plant species, substituting the dominance of cattails by a mosaic of plant species. Local changes in the water inflow caused by the deviation of an ephemeral stream seem to be the main cause on the changes observed on the plant dynamic and structure of the wetland.

Keywords: wetland, Costa Rica, *Typha dominguensis*.

Decision support for wetland management: two experiences from the Netherlands

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Decision support systems (DSS) are increasingly popular tools in integrated water management. However, the achievements of DSS tools in water management projects have been modest. It is questioned whether (often technocratic) decision support tools are still equipped to support complex wetland management projects where different stakeholders and governmental agencies interact. In the Netherlands but also outside, there is a tendency towards decentralisation and various stakeholders as well as various governmental agencies are involved in the decision-making. Two relatively simple and flexible tools have been developed that aim at facilitating discussions and negotiation situations in wetland management and decision making. Based on experiences with both tools it is concluded that application of these relatively simple tools is promising. These tools can help to overcome unnecessary conflicts, stimulate collaborative planning, help to structure the problem and provide insight in values and preferences of stakeholders involved in the project. It is important for these tools to be simple and flexible so that the stakeholders can change data or incorporate their own views and preferences into the system. A second conclusion is that application of these tools should be limited to preparatory phases of decision-making. Focussing on preliminary phases prior to actual negotiations seems to increase the chance of successful use of the tool. Thirdly, it is concluded that the limited success of decision support tools is probably largely due to a) a mismatch between problem and tool, and b) the reluctance of decision makers to involve rationalizing tools in the final negotiation stages of decision making.

Keywords: decision support, wetlands, multicriteria analysis, participatory planning.

Riparian vegetation: a basic element of fluvial systems' restoration

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Rivers of the Iberian Peninsula reflect centuries of land-use changes to their watersheds. Historically, river modifications resulted from deforestation, land conversion to agriculture, and elimination of riparian vegetation. More recently, rivers have been dredged and straightened, flood defences and dams constructed, and gravel has been removed from beds and floodplains. This study examined relationships between riparian vegetation and fluvial attributes, and assessed the value of otter as an indicator of the physical integrity of fluvial systems in five rivers of Huesca, Spain. Riparian vegetation was assessed using systematic field surveys and air photo analysis. The relative abundance of otter signs and fluvial characteristics of selected reaches were determined in 600m transects along the main channels, with a total of 22 transects distributed among the five study rivers. In upland valley reaches, the proportion of forest within a 50m wide riparian strip is significantly and negatively correlated with the channel wetted-width to depth ratio. The percent of forest within the riparian strip is positively correlated with the amount of large woody debris. The density of spraints per 100m of bank surveyed is positively correlated with channel wetted width, and the density of otter spraints per square meter of wetted surface with the percent of residual pool habitat per channel length, and negatively correlated with sparsely vegetated areas within the riparian strip. These results confirm the important contribution of riparian trees in bank protection, resulting in narrower and deeper channels. However, in these rivers, trees in the riparian strip appear to be too small and scarce to supply enough large woody debris to significantly influence channel and aquatic habitat structure. Reclaiming of riparian corridors and floodplains by mature vegetation communities should stabilize streambanks. The development of riparian forest communities will likely increase the amount of woody debris, which will enhance sediment deposition, vegetation re-colonization in river margins, and formation of vegetated islands. Notwithstanding the fact that river otter is an important component of fluvial ecosystems, this species is likely not a good indicator of ecological integrity because its density may not vary with such important factors as changes in the composition of fish communities. However, in rivers unimpaired by drastic changes in habitat or water quality, otter density would indicate abundance of fish and the physical condition of the riparian-fluvial system.

Keywords: riparian vegetation, integrity, streambank.

Three Species Models for Interacting Populations

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There are real world concerns that make the study of population dynamics important, not the least of which conservation management of wildlife. In this field, the interaction between species is highly complex and it is generally accepted that these relationships should be disturbed as little as possible. However, this interaction often results in the necessary control of populations and thus population models are important tools for the prediction of such controls. A case study of such a situation is discussed: In the Ndumo Game Reserve in KwaZulu-Natal, South Africa, the over-crowded nyala and impala populations have a detrimental effect on other species and vegetation structures. Officials have been trying to control the nyala and impala numbers with culling over the last two decades, without success. A mathematical model for competing species is used to investigate reasons for failure, and seek an effective culling program to control their numbers and prevent extinction of smaller species, such as bushbuck and red duiker. Mathematical solutions to wildlife management problems, in general, are sought on the platform of computer-interpreted models for three interacting species. A cropping term of varying order is introduced to the systems of nonlinear differential equations to determine possible long-term solutions. Phase plane analyses suggest expected outcomes of the different cropping strategies over time. This allows the wildlife manager to evaluate the options suggested without actually killing the animals, or investigate the effect of deviations from a chosen program. The models are extremely simple and conservative, considering all the variables that can have an effect on the dynamics of populations, but nevertheless suggest directions for action.

Keywords: Wildlife management, mathematical models, population dynamics, culling.

Predictability of restoration outcome under a changing climate; examples from a lowland country

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Increased summer rains is only one effects of global warming in Western Europe. In lowland countries this has consequences for water management and coastal defence. Global warming and landscape planning are, therefore, different sides of the same coin. Restoration measures in most European countries have been aimed at restoring old cultural landscapes. We may expect, therefore, that the outcome of many restoration projects will not always lead to the goals that have been set. We have monitored several restoration projects in the Netherlands for more than 10 years and will present evidence that in several cases global warming has frustrated the gaols of restoration. We studied a chronosequence of dune slack succession in the Wadden Sea island of Terschelling covering a time scale of 80 years and found that increased summer precipitation during the last decade prevent the restoration of calcareous pioneer communities. Coastal defence structures (large sand dunes) set limits to restoration since they prevent the natural discharge of excess surface water. Under such conditions restoration of natural pioneer stages is no longer possible. In a similar way the restoration of mesotrophic fen meadows in various polder areas has become almost impossible, due to long-term drainage in the surrounding of the reserves and increased summer floods. Under such conditions it is necessary to chose restoration goals that can be sustained by the present landscape under the influence of global warming and a changing water management regime.

Keywords: dune slacks, fen meadows, hydrology, succession, water management.

Experience and Expertise: Robust Restoration Strategies in a Real World Context

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Many ecological restoration projects are taking place in areas populated by humans, so negotiations between heterogeneous actors involved and reactions to developments in different ecosystems become part of restoration work. However, this does not necessarily mean that scientific rationality is being undermined or even being superseded by a new type of socially robust knowledge production where the epistemological core has being emptied – as is recently proposed by some science studies scholars. Based on a

set of studies of ecological restoration projects in North America and Europe this presentation will illustrate how the wider public's experience-based expertise can become part of scientific work. This, it is further contended, does not substitute for scientific reliability in the form of "socially robust knowledge" a.k.a. an empty epistemological core of science. Instead, new knowledge – "lay" as well as "expert" – can be fed into each new step of restoration implementation to expose it to further observation so that the production of ecological knowledge and its application are recursively linked to each other.

Keywords: restoration as public science, recursive learning, socially robust implementation, new knowledge production.

Landscape design as a tool for strategic planning for land forest landscape restoration

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Landscape restoration in human-dominated forest lands must account for the complexitiesy and needs of integrating the needs of wildlife and people use, restoration and maintenance of key habitats and protection withinacross a mosaic of different land uses. This paper presents the landscape design as a strategic tool for forest landscape restoration planning based on the suitability of land use allocation. In this approach we include the concept of ecological integrity of the ecosystem, which that implies biodiversity conservation, sustainable forest rescourcses and management of others non-timber forest products managements, ecosystem services and functions such as like erosion control, maintenance of water supplies, recourses and wildlife habitat protection. Relating to theseis multiple proposes we consider different ecosystem attributes and an active participatory design planning process. The varying interests of different stakeholders interested ion land use (conservation, cultural, economics, etc) are an important issue to be considered in negotiating an agreed set of actionslandscape planning process for successful actions. The multi-criteria and multi-objective decision making approach appears to provide a useful as a good tools for evaluating the multipurpose nature of land allocation in a complex system in which human and natural processes interacts at different spatial and temporal scales. This planning tool provides a comprehensive, but also increases the accountableility and, efficiencyt and more compressive approaches to forest land design at the landscape scale. This approach can be applied through a series of steps from broader scalehas different step of action: eco-regional planning down to a finer scale at theand local level planning, where participation of different local social groups is essential to achieve a planning consensus.

Keywords: forest, design, landscape, scales.

Restoration of natural cover in olive old-fields: from landscape to site scale

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In the Iberian Peninsula there are more than 2.500.000 ha of olive crops, with more than two third of this surface concentrated in Andalucia, a region in the south of Spain. Part of this surface is marginal from an agronomic and ecological point of view, being potentially affected by a future abandonment. As a consequence of the high heterogeneity of mediterranean ecosystems, it is difficult to establish the endpoints of the plant succesion; nevertheless, it is a matter of need to develop tools in order to support managing decisions affecting these areas. After abandonment, natural processes lead to restoration of natural vegetation cover. As a consequence of the high heterogeneity of mediterranean ecosystems, it is difficult to predict the future trajectory of succession. Natural reforestation occurred in many areas, resulting in complex mosaics of land uses that characterize the region today. In this work, a tool for modelling the restoration of natural cover in marginal olive groves areas at a landscape level is exposed. A qualitative index of marginality for the olive cultivation in Andalusia has been dessigned using the following source of data: digital geographic information of the land use obtained from aerial photographs 1:60,000, digital soil map of Andalusia (1:400,000); and a vector map of slopes with cell of 20x20 m over topographic map (1:50,000). According to this model, 16% of Andalusian olive plantations can be considered as marginal and have a clear risk of abandonment.

The extent and spatial pattern of the potential recovery in each landscape were evaluated by an index of colonisation potential defined for each natural vegetation type according to the capacity for establishing wood or shrubland communities in adjacent marginal olive polygons. A distance of 500 m was considered

to be the maximum effective dispersal distance, considering the variability of the reproductive strategies of mediterranean plant species and the scale of work. Next, we separately overlaid the olive grove cover map and the forest cover maps to produce new maps of the potential forest recovery on each landscape type. Through the intersect module of ArcView, marginal olives polygons situated less than 500 m from natural vegetation, with the potential to be colonised by forest or shrub communities, were distinguished from marginal olive groves with no such opportunities. We then compare the metrics of the patches among the different olive areas, including in the analysis the plant cover data obtained from an field survey in olive-fields with different age of abandonment.

Keywords: modelling, olive, index of colonisation.

Predictability of restoration outcome based on responses of vegetation and arthropod communities in a dry grassland experiment

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Although there is much literature on studies combining vegetation and arthropod diversity in relation to successional stages or land use type and intensity, similar investigations in relation to restoration have become important only recently. In the present paper we compare the indicator value of vegetation and ground-dwelling arthropods in predicting the outcome of a dry grassland restoration experiment in a low productive area of the Hungarian lowland. The aim of the experiment was to develop methodologies for the eradication of an invasive species, black locust and to restore clear-cut sites to a semi-natural grassland ecosystem. Clear-cutting was carried out in early spring of 1995. Re-sprouting was repressed by herbicide application. Mowing was applied to remove the nutrient surplus accumulated by *Robinia pseudoacacia* and for weed control. After the first five years of treatments, vegetation development had two different pathways depending on the presence or lack of mowing. After the removal of the tree canopy we experienced shrub encroachment and an increasing abundance of species characteristic to closed grasslands and *Robinia* plantations. Mowing controlled the expansion of shrubs and prevented the grassland from closing, but the continuous disturbance resulted in the dominance of annual species. Early vegetation development did not show approaching trend towards the target grassland, but eight years after the initial treatment phase, the succession seemed to move in the desired direction. The two pathways of succession were confirmed also by the arthropod data, as generalist arthropod species reflect the structure of vegetation rather than its composition.

Keywords: Grassland, arthropods, black locust, invasive species.

Art and ecology for extreme environments

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Since the 1970s N.A.S.S.A. has worked with the Rhode Island School of Design to analyse and design for the needs of humans living in weightless and other 'extreme environments'. The focus of this research programme and its applications have actually been quite narrow and largely constrained by a problem based learning culture. This paper will, therefore, consider the use of ecological art forms as a means of adapting to climate change through inquiry based learning. With occasional distractions, Western Culture has maintained a course of action to increase the gap between human life and 'nature'. However, this interdisciplinary arts approach extends the notion of restoration beyond the remediation of damaged ecosystems to consider creative approaches for inventing dynamic processes in response to dynamic, living situations. All species find themselves increasingly under stress, facing extinction or evolution. It's time to think the unthinkable and change unsustainable lifestyles and move to an embodied ecology. Using case studies that integrate the natural sciences, social sciences and the creative arts, this paper will offer some practical examples of projects engaged in creating ecologies to meet extreme environments.

Keywords: Art, Embodied Ecology, Extreme Environments, Climate Change.

Community Involvement in river restoration in south-west Western Australia

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The rivers of WA's south-west present unique challenges as they are highly variable, predominantly seasonal and often sandy and therefore unstable. Providing stable habitat and protecting and restoring river pools for summer refuge are important river management objectives in these river systems. This paper outlines a number of river restoration case studies in south-west Western Australia detailing the techniques applied, the results and the key learnings. The projects have mostly been low cost, and successfully undertaken with land holders and local community groups. The restoration sites have become demonstrations of best management practices and have been used for community education and training purposes to encourage broader adoption of the techniques. The case studies outlined in this paper include works to: enhance habitat with rock riffles and large woody debris, provide fish passage over weirs, establish livestock crossings and off-stream watering points, and stabilise the bed and banks of waterways using a variety of techniques.

Keywords: river restoration, fishways, stabilisation, community involvement.

Before, during, & after road construction (Practice and Policy Opportunities)

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Weeds or invasive plants get in the way of restoration success. - Highway revegetation is not restoration, you say. Restoration is defined in many ways.I chose to use"repair of a highly disturbed landscape to reflect its original natural heritage to the extent practicable" as the definition used by more and more State Departments of Transportation (DOT) in the United States. As their corridors crisscross the nation through both private and public sector lands; what DOTs plant and the success they have makes a difference to all land managers. It is widely believed, however that highway corridors are considered pathways of unwanted plant invasion. I chose to regard corridors as potential conservation byways that can serve as buffers to agricultural and natural lands. By restoring roadsides and medians to native plantings, many States like Iowa contend that their efforts resist further movement of weeds through or off their corridors. So how do we get the weeds out of our way to restore native grasses and forbs before and during construction efforts? Anyone in the restoration world have the same project problem; prevention and control are essential. Best practices to prevent the spread of weeds is evolving. Reporting about roadside restoration, the author will explain the policy obstacles associated with highway construction projects in the United States. An important piece is the National Environmental Policy Act (NEPA) process in highway construction projects, which requires both public and public agency input. Connecting such pieces through restoration is an opportunity that should not be missed. However, the idea needs to be a part of policy and plan before an alignment is chosen. And there in lie obstacles. Ecological restoration of damaged sites after highway construction might not be completely compatible with the goals of restoration, but it is a repair opportunity. Not planting invasive plants, designing alignments around remnant vegetation, and saving existing pieces is a good start. What precedents now exist in the United States to accomplish this stewardship goal? How can NEPA help prevent the spread of invasive plants?. What partnerships are now possible?. That and related questions will be answered in this report.

Keywords: invasive plants, weeds, policy, NEPA, highway construction.

Saving the redwoods: new strategies for redwood forest conservation

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Since 1918, Save-the-Redwoods League has led the movement to protect the ancient redwood forest. Current forest restoration projects in the northern redwood region will be placed in context of a broader redwood conservation strategy. Historically, the League focused on protection of the most inspirational stands of ancient redwood forest within a series of representative parks and reserves. As our understanding of the forces affecting the forest has developed, the League's conservation work has evolved to consider protection of the redwood forest ecosystem within a network of parks, reserves, and managed forest land. With more than 95% of the ancient redwood forest logged – including forestland now protected in parks and reserves - a key challenge faced across the redwood region is restoration of degraded forestland towards old-forest conditions. The paper will describe the League's current science-based conservation strategy, discuss the

use of GIS technology and conservation planning methods to better identify priority protection and restoration opportunities, and describe how the League has worked with the scientific community to build the base of information to support its conservation work. The Mill Creek ecological restoration project will be presented as a case-study of collaborative forest restoration across a 25,000-acre watershed.

Keywords: redwoods, conservation, forests, restoration.

The Prestige Wreck Fuel Recovery Project

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This article is intended to provide a detailed overview of the recovery project devised to extract the hydrocarbons remaining in the wreck of the "Prestige" tanker. The ship, carrying some 77,000 Tm of heavy fuel oil broke up and sunk in 3850 meters water depth in November 2002, 150 miles off the north western coast of Spain. During the sinking, and for a period of several months afterward, a large amount of fuel was spilt ending up mainly on the shores of Galicia.

Repsol YPF, though in no way connected to the vessel or its cargo, was appointed by the Spanish government to recover the fuel remaining inside the wreck. Later Repsol YPF selected Sonsub as the main contractor.

The initial campaign, carried out in 2003, involved the design and construction of the tools required to operate a those depths, sealing off all remaining leaks in the wreck, conducting a comprehensive data acquisition and research campaign that included measuring the fuel remaining inside the wreck's tanks and carrying out a pilot test of a novel batch extraction method which involved the development of a safe system to perforate the wreck's deck and control the extraction of fuel.

The extraction of the remaining fuel was carried out in 2004 using large volume aluminium shuttles. An innovative core-flow technique was used to extract this extremely viscous fuel (some 500,000 centipoises at the shuttle offloading conditions) from the shuttles and offload it into a Floating Storage and Offload (FSO) vessel. Finally, a bio-remediation procedure to accelerate the biodegradation of the immobile fuel was implemented.

Details of the different aspects of the project are described in separate papers, see References.

The Repsol YPF Prestige Recovery Project has won the prestigious Energy Engineering Project of the Year award at the Platts Global Energy Awards for 2004.

Keywords: fuel recover, core-flow technique, Prestige.

2D water quality modelling in a eutrophicated shallow coastal lakes - application for "l'Albufera de Valencia" restoration plan (Spain)

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Albufera of Valencia is one of the most important shallow Mediterranean lakes in the Spanish coastal region. It has been suffering from eutrophication and sediment pollution with heavy metals since the 1960's. The sources of pollution are agriculture, urban waste waters and industry. A 2D water quality model has been set up in the simulation package Sobek, as a tool for the long term development of the water quality in the lake and to enhance the insight in the aquatic ecosystem. With this tool, various measures are investigated, concerning improved treatment of urban waste waters and sustainable agriculture. The water quality model reproduces the spatial and temporal variation in the growth of algae, the nutrient cycles, dissolved oxygen and heavy metals in the sediment. The model turned out to be a useful tool for the study of the sustainable development of the Albufera of Valencia.

Keywords: water quality modelling, shallow lakes, eutrophication, sediment, environmental flows, Sobek.

Hydrological restoration programs and natural regeneration in mangrove areas at the northern coast of Yucatan Península, Mexico

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Land use changes and modifications of the hydrological regime are major factors causing of decreased mangrove forest coverage. In the northern coast of Yucatan Peninsula, SE Mexico, mangrove coverage decreased about 40% for the last 30 years, promoted by deforestation, urbanization, road construction, and artificial coastal openings which modified the hydrological regime. In order to restore the functional processes in the impacted zones, two actions were implemented: one without scientific information, which consisted on building culverts in coastal roads o facilitate water flow, and another, an experimental research to know the processes leading to natural regeneration of mangrove in karstic sediments and to define the specific environmental variables determining these processes in order to identify potential areas of successful mangrove regeneration. Results from the first approach, indicated that the objectives were not achieved because no changes in the mangrove structural development and hydrological conditions were observed. High water salinity was probably a major environmental stressor for mangrove growth in this area. Opening culverts was not only inefficient for mangrove regeneration but also favored increasing the salinization process. The second approach showed that a mixture of biological (structural conditions of the forest) and environmental (water flow, hydroperiod, salinity and temperature) factors were important factors for natural regeneration of mangroves.

Keywords: mangrove, forest, water flow, salinity, hydroperiod.

ECOPEY, a Mexican Long Term Ecological Research site: toward understand key ecological processes and application to restoration programs

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Ecosystem characteristics as primary production, nutrient and water dynamics, biodiversity, response to disturbances, climate change effects and management and conservation criteria, are thematic areas of the Mexican Long Term Ecological Research Network (Mex-LTER), which has as a major objective improving the understanding of ecosystem processes that have long-term actions or effects. ECOPEY is a group of the Mex-LTER conducting long-term monitoring program in the coastal lagoon of Celestun (Yucatan Peninsula). Long-term perspective and research is required for defining restoration plans for coastal ecosystems because they are regulated by processes changing at long-term scale. Also long-term studies are important to know the links between terrestrial and aquatic ecosystems in coastal zones. Long-term monitoring is applied to know changes of Celestun lagoon ecosystem in order to identify spatial and seasonal patterns of ecological processes and to understand its stability and resilience as ecosystem in front of local and global changes, and how this information can be incorporated to restoration programs.

Keywords: ecosystem processes, long-term analysis, restoration, Mex-LTER, coastal lagoons.

Monitoring Ecological Processes in Restoration Projects

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Restoration of ecological processes is key to restoration project sustainability, yet most restoration monitoring is limited to plant community composition. Our research has shown that short-term plant composition monitoring is a necessary but insufficient predictor of long-term restoration success. Long-term (up to 75 years) studies in the western United States show that short-term monitoring of plant community composition alone incorrectly predicted the failure of treatments that were ultimately successful, and the success of treatments that ultimately failed. We propose that vegetation composition monitoring be combined with one or more ecological process indicators. These simple, rapid, plot-level indicators reflect changes in resource redistribution and vegetation structure. Several of these indicators can be quantified using new remote sensing imagery analysis tools. New indicators reflecting landscape-scale processes are also being developed and can be adapted to monitor restoration project suc-

cess. Landscape-scale indicators are necessary for both restoration project design and monitoring, especially in arid and semi-arid ecosystems where there is often a high level of resource redistribution among landscape units due to high rates of runoff, wind and water erosion. Animal activity and restoration treatments themselves can lead to further modifications in resource redistribution processes.

Keywords: Indicators, runoff, erosion, landscape, spatial variability, resource redistribution.

Before and After Restoration: A Preliminary Case Study on the Role of Social and Cultural Factors in Ecological Restoration

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Ecological restoration usually becomes necessary due to careless human interventions in natural environments. Once ecological restoration has been accomplished, the successful continuation of restorative processes generally depends on the cooperation and good will of local resident populations. Consequently, it is of the first priority to determine the social and cultural factors that, respectively, generate a) careless and b) careful behaviours toward natural environments under risk. Rivers are key to ecological functioning at the landscape level, and so our preliminary case study appropriately explores common attitudes and behaviours of local populations toward riparian-fluvial systems. Our presentation will begin with the introduction of examples of attitudes and behaviours, both of care and of carelessness toward riparian-fluvial systems, in the region of Aragón, Spain. Next, we consider values, which promote sustainability and care for proximate environments, and bring those values into relation with those observed in Aragón. Finally, we make recommendations for an integrated, interdisciplinary research project that can further clarify the social and cultural conditions necessary for the active engagement of local resident populations with, and their cooperation in, the maintenance of such environments.

Keywords: restoration, social, interdisciplinary research, landscape.

The Rockies Through the Lens of Time: Repeat Photography and the Challenge of Ecological Restoration

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Working with perhaps the largest systematic collection of historical mountain photographs--more than 70,000 survey images used to map the mountainous regions of western Canada in the late 19th and early 20th centuries—our team has undertaken repeat photography with a portion of the collection to interpret and analyze the qualities and extent of change in Waterton Lakes National Park. Waterton, one of Canada's most celebrated and vulnerable protected mountain areas, is part of the Waterton-Glacier International Peace Park and is a World Heritage Site. Our goal is providing finely resolved historical information for effective ecological restoration of vulnerable landscapes. This presentation provides an overview of the historical and repeat photographic surveys, the challenge presented to restoration planning by snapshots of historical information, and three specific research projects based in part on the photography: disturbance regimes in subalpine forest communities; the dynamics of aspen (*Populus tremuloides*)-grassland communities in areas of heavy human use; and, tracking the content and use of the imagery in the development of Canadian attitudes toward nature.

Keywords: restoration, history, parks, subalpine, repeat photography, *Populus tremuloides*, cultural change.

Guidelines for the Ecological Restoration of the Andean Basins in Colombia

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The Oriental Hills of Bogota D.C. (Oriental mountains of the Andes) have been enduring during the last decades some intensive human alterations, such as deforestation, forest and agricultural cultivation, urbanizations, etc, that have broken the natural balance of the native ecosystems. The basin "La Floresta-

Novita" is a relevant Forest Reservation Area since 1976 and contains some areas with geotechnical stability problems, hydrological and mesoclimatic alterations, and invasion of species, as consequence of the inadequate human activities. Based on a detailed analysis of the current conditions including the evaluation of soil losses, our diagnosis define four biophysic areas, with an integral approach that considers the applicable restoration techniques in each case: 1) Preservation (P), 2) Total Rehabilitation (TR), 3) Environmental Recovery (ER) and 4) Limited Rehabilitation (LR). With the premise of prioritize the restoration of the most degraded areas using a basic serial scheme, the following measures have been designed: 1) the induction of bushes and stubbles coupled with the restoration of forest gaps (TR); 2) the gradual conversion of the plantations of eucalyptus to native forest (ER); 3) the utilization of organic nets, protective plantations forming blocks, vegetal wind-shields and "friendly" gardening (LR). These technologies are based on the increase of the water availability and the recovery of the native vegetation, and aim to minimize the actual social and ecological degradation of the basin. Their objective is to promote a sustainable development of each of the constituent elements and also to define the guidelines for the ecological restoration of the Oriental Hills of Bogota D.C.

Keywords: Andean basin, ecological restoration, Colombia.

Long-term studies of California grassland: lessons for restoration

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A 20 year study of annual grassland on serpentine soils in northern California elucidated the roles of rainfall variation and disturbance in determining grassland composition and dynamics. The abundance of individual species was found to vary markedly over the study period, in part tracking changes in annual rainfall amounts and distribution, but also varying in relation to animal disturbance and grazing. This led to large variations in species composition both through time and spatially. Of particular importance were the findings that invasion by non-native grasses was episodic and related to above-normal rainfall amounts and that some species which were relatively uncommon in the grassland became dominant under some conditions. These dynamics would not have been elucidated without long-term study. The relevance of the dynamic nature of the grassland, the spatial heterogeneity and the functional roles of individual species are considered within the context of restoration. In particular, the question of setting restoration goals in relation to a reference system is explored. Clearly, the objectives of restoration need to take into account both the dynamic nature of ecosystems and the need to build functional resilience in the system. Similarly, the definition of a reference state needs to recognize the possibility that species which are not abundant at one particular time may nevertheless be important components of the system under changed conditions.

Keywords: serpentine grassland; gopher disturbance, rainfall variation; resilience; restoration goals.

Setting restoration goals: mixing ecological theory with social values

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Worldwide, restoration of degraded ecosystems is becoming a priority activity, and large amounts of time and money are being invested in restoration projects. Our understanding of ecosystem dynamics has changed dramatically in recent decades, and ecosystems are seen as more complex and less predictable than previously. Setting achievable and realistic goals for restoration projects depends on understanding ecosystem and landscape dynamics within a changing global environment, and translating this into conceptual and practical frameworks for restoration. In addition, however, restoration goals are frequently set within the context of a set of social, ethical and other values which may or may not be congruent with the ecological constraints to be overcome. Reconciling the potential mismatch between ecological constraints and social expectations and decisions based on disparate value sets is an important challenge for ecological restoration. Clearer understanding of ecosystem dynamics and better articulation of realistic restoration goals can lead to much improved restoration success and better investment of government and private funds.

Keywords: serpentine grassland; gopher disturbance, rainfall variation; resilience; restoration goals.

Restoring freshwater wetlands in Denmark

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A national programme for the restoration of freshwater wetlands in Denmark was initiated in 1998. The purpose was to reduce nitrogen load to down-stream recipients and to enhance nature values in restored areas. The government issued a circular as a tool for the Danish counties to point out areas, which had the potential for being restored as wetlands. Criteria for pointing out the areas implied that: 1. Project areas should be situated in catchment areas discharging to vulnerable fjords, waters, and lakes, where an improvement in the environmental condition could be expected as a consequence of a reduction of the nitrogen load, 2. Project areas should lie in agricultural catchments, where streams and rivers receive high nitrogen loads or in areas where groundwater is influenced by agricultural activity, 3. Project areas should lie in areas where the natural hydrological and topographical conditions would lead to formation of wetlands with a watertable fluctuating around the soil surface, 4. Nature values should be enhanced, 5. Leaching of phosphorous to down stream recipients was not allowed. At present, i.e. March 2005, 2900 ha of land have been restored and 4700 ha of land have been approved for restoration. A monitoring programme for surveying the effects of the restoration of the wetlands has been set up. The programme includes both surveys of environmental effects such as nutrients, and natural values such as vegetation, birds and otter. Nutrients have been surveyed in 15 wetlands, vegetation in 8 and birds in 10 wetlands.

Keywords: legislation, implementation, natural values, nitrate removal, monitoring programme.

Reconstruction of temporal habitat dynamics (1817–1991): a basis for the rehabilitation of Austrian Danube river landscapes

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Modern river/floodplain rehabilitation concepts focus on the original, natural functions and processes typical for the particular river ecosystem. Rehabilitation measures are currently being discussed or implemented for various channelized Austrian Danube river sections, calling for profound analyses of the pristine riverine habitat conditions. A research project on the alluvial Danube river landscape in the Machland (Upper/Lower Austria) aims to reconstruct former temporal habitat dynamics based on the analyses of historical sources between 1715 and 1991. The main issues are: (1) the typical habitat age distributions prior to channelization, (2) whether certain habitat types experienced long-lasting aging processes rather than short life spans effected by intensive fluvial dynamics and (3) the overall age development of the system following river channelization. The vector/raster GIS analyses indicate a dynamic equilibrium of both habitat aging and rejuvenation, yielding a high diversity of differently developed habitats and a balanced age distribution of the total ecosystem. This supports the hypothesis of a former natural age structure typical for the alluvial sections of the Austrian Danube River over the long term. The age analysis also reveals that certain aquatic and terrestrial types of habitats showed very short life spans. River channelization and hydropower plant construction considerably affected the natural habitat age diversities: the initial channelization measures (1829 – 1838) led to artificially enforced habitat rejuvenation. The period after channelization (1859 – 1991) was characterized by significantly altered age distributions and substantially increased aging of the total system.

Keywords: Danube River, habitat age, habitat dynamics, age distribution, historical change, river rehabilitation.

Forest and MIre Restoration in Finland in METSO-programme

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The Forest Biodiversity Programme for Southern Finland (METSO) started in 2003. One goal of the programme is to restore 33 000 ha of mires drained for forestry and forests used earlier for forestry during the period 2003-2012. These areas are situated in the protected areas in Southern and Western Finland and are governed by Metsähallitus. The main restoration measures in forests increase the amount of dead and decaying wood, and create small openings and burning. The amount of dead and decaying wood is increased primarily in areas, where the natural continuum of decaying wood is in danger of being severed, and in areas lacking decaying wood. Burning and small openings are usually done in

young, monotonous conifer forests. In mires ditches are filled, or if there is not enough peat left to fill the ditches, they can be dammed. In some areas trees are also removed to prevent the evopo-transpiration. The main reason for the restoration is to protect threatened species and their habitats. Saplings and trees are monitored in some forest restoration areas. In mires the movements of water and the amount of saplings are monitored. In some areas species inventories will also be done. Restoration costs are estimated to be 17 million euros. Most of the restoration work is done in winter by forest workers, which has a positive effect on winter employment of forest workers.

Keywords: Forests, peatlands, restoration.

"CarbonTender" - Low Cost Restoration and Biosequestration

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CarbonTender was designed to develop and assess mechanisms for purchasing low-cost, carbon sequestration rights that also provide measurable and genuine biodiversity outcomes. The Victorian State Government sought to purchase up to $2.3 million of carbon rights generated from restoring forests and woodlands to specific biodiversity standards. The State has acted as an investor using a ""market-like mechanism". Restoration sites were designed to optimise adaptations to a changing climate. New vegetation must reach minimum area thresholds and be located to link and buffer existing patches. Additionally a large range of lifeforms and species are used to provide resilience to a changing climate. The potential carbon value of each site was calculated. Bids (or tenders) were then received for eligible sites. Contracts were then allocated to best value sites to maximise biodiversity and carbon benefits from these funds. Landholders and the State then entered long term agreements that provide effective permanent protection for the site. Contracts were offered for 26 restoration sites at a median price of $AUS 16.20 per tonne of CO_2. CarbonTender demonstrates that significant measurable biodiversity benefits can be obtained from low cost carbon investments. A tender process can reveal low cost suppliers, provided the required outputs are well described. Improved legal, technical and accounting mechanisms can now inform private investors seeking both biodiversity and carbon gains. This approach also rewards innovative landholders.

Keywords: Climate change adaptation, carbon sequestration, tender, auction, biodiversity, carbon sinks.

Up scaling restoration in highly populated environments

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In many areas of Latin America forest remnants are both structurally and spatially fragmented. Their ecological dynamic and environmental services are highly threatened. Forest restoration to rebuild biological corridors, mitigate fragmentation impacts and rehabilitate degraded patches will be a must in the near future. Most of this areas are also highly populated by either indigenous or rural communities. The challenge in this areas is to develop forest restoration strategies that effectively articulates biodiversity conservation and rural development goals. These strategies should be based on a thorough conceptualization of the ecological and socioeconomic factors that are influencing the current situation and the proposed long term goals. The status of each factor and its relative influence varies with the recurrent changes in Latin America's sociopolitical context; consequently, an adaptive management approach is recommended. In this study case, a strategy based on the production of "non-timber forest products" to increase production capacity of mid size land owners is test as a mechanism to upscale forest restoration in the Upper Parana Atlantic Forest.

Keywords: Landscape restoration, Latin America restorations, forest restorations, adaptive management, NTFP.

Natural regeneration in abandoned farming fields: site and landscape scale integrated analysis in the Atlantic Forest

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The Atlantic Forest has become greatly reduced on account of the advance of the farming frontier. In the Province of Misiones (Argentina) many farming fields have been abandoned, giving way to a patchwork mosaic of secondary forest of different ages. The objective of this study is to analyze the secondary forest structure, its successional tendency and regeneration in relation to the land-use history and abandonment periods, on a local and landscape scale. Vegetation censuses were carried out in Misiones forests with abandonment ages ranging from 3 to 70 years old. Landscape changes were evaluated by analyzing the surrounding cover on different spatial and temporal scales making use of satellite images. Censuses data were studied through ordering methods. In some sites, species replacement followed a pioneer – early – late trajectory, whereas in others the replacement pattern was not so clear. We have concluded that as regards structural parameters, 20 to 30 year-old forests are similar to mature forests; however, these differ with the latter in their floristic composition. The discussion of the present study focuses on the relationship between successional trajectories, species' ecological features, land-use and changes on a landscape scale.

Keywords: Secondary forest, natural regeneration, successional trajectories.

Flood-meadow restoration along the northern Upper Rhine

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Regularly flooded meadows along large lowland rivers in subcontinental climates belong to the most endangered plant communities in Europe. Previous efforts to restore these highly endangered communities from ex-arable fields proved to be frustratingly unsuccessful: Even after the opening of dykes and the successful lowering of productivity by hay-making most of the desired target species did not re-establish. This was obviously caused by seed and probably also microsite-limitation. To overcome seed dispersal limitation we transferred mown plant material from species-rich target communities to restoration sites. This method was first tested at relatively small (1.3 ha) scale in combination with topsoil removal, which should provide particularly favourable conditions for seedling recruitment. In a second, larger scaled project (46 ha) we applied the transfer of seed containing plant material to restoration sites on ex-arable fields and improved grasslands without topsoil removal and consequently higher levels of productivity and interference by the established vegetation. Generally, diaspore transfer with mown plant material proved to be an extremely successful method to overcome dispersal limitation of target species in habitat restoration. However, recruitment success was strongly controlled by the degree of competition through the established vegetation as well as by seasonal fluctuations in moisture conditions induced by flooding events and summer drought.

Keywords: Restoration, floodplain, grassland, diaspore transfer, seed limitation.

RECONDES: Use of vegetation in landscape configurations to combat desertification

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RECONDES is an EU funded research project on 'Conditions for Restoration and Mitigation in Desertified Areas Using Vegetation'. Its focus is to identify how vegetation may be used to reduce erosion in specific landscape configurations prone to severe degradation processes. Its major objective is to produce practical guidelines on the conditions for use of vegetation in areas vulnerable to desertification, taking into account spatial variability in geomorphological and human-driven processes related to degradation and desertification. RECONDES is being applied to the marginal lands of the north Mediterranean which are vulnerable to or have suffered desertification. Field measurements of vegetation and process interactions are being made in Murcia, Spain and Tuscany, Italy. The research is based on six land units, combined in a hierarchy of scales: Reforested land, Rainfed cropland, Semi-natural and abandoned land (Scale 1); Hillslopes, River valleys (Scale 2); Small Catchments (Scale 3). The project aims to identify the conditions necessary for growth and survival of various kinds of vegetation and examine where those conditions are

found. This is the present phase of research. This knowledge will then be used to match those conditions against the processes of degradation to identify where treatments or restoration will be most effective. Crucially, it will examine linkages within the landscape at different scales to determine the key points for intervention. This paper will discuss the approach and underlying conceptual models, the methods used for measuring conditions and for identifying limits and thresholds, and the preliminary results.

Keywords: Desertification, land degradation, soil erosion, pattern, vegetation.

Landscape-scale indicators of Laurentian Great Lakes ecosystem health

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The State of the Lakes Ecosystem Conferences (SOLEC) were held beginning in 1994 in response to reporting requirements of the Great Lakes Water Quality Agreement between the U.S. and Canada. The biennial conferences provide landscape-scale, independent, science-based reporting on the health of the Great Lakes ecosystem based on the success of ecological restoration and remediation projects. A suite of indicators necessary and sufficient to assess Great Lakes ecosystem status was introduced in 1998, and assessments based on a subset of the indicators were presented in 2000. Because SOLEC is a multi-agency, multi-jurisdictional reporting venue, the SOLEC indicators require acceptance by a broad spectrum of stakeholders. Indicator reports provide the basis for government agencies and other organizations to collaborate more effectively and to allocate resources to data collection, evaluation and reporting on the state of the Great Lakes basin ecosystem. This paper will detail how Great Lakes partners approach ecological restoration at the landscape-scale using a suite of indicators to help guide the management of a diversity of habitats and populations.

Keywords: Laurentian Great Lakes, State of the Lakes Ecosystem Conference (SOLEC), Great Lakes Water Quality Agreement, indicators, ecological restoration.

Environmental risk management: controlling the subsoil contamination

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The “ventas directas y aviación” area of repsol ypf group, has developed a management procedure based on the risk control at potential polluted sites. The project began with the systematic review of the environmental state of soils and groundwater and with the analysis of potential risk derived from pollution. This review allowed the discrimination of contaminated sites and the establishment of the priorities for performance. Further on, remediation labours started in places with high risk level. In many cases remediation had been coordinated with remodelling works destined to prevent new contaminant impacts. Remodelling works are an important support in risk control. The sites with no significant impact on the subsoil but a high level of potential risk due to their geographical-geological setting, have been included in a prevention program directed to protect the soil taking into account the particular characteristics of every installation.

Keywords: risk, remediation, groundwater, prevention program.

Fire as a Tool in Restoring Beetle (Coleoptera) Assemblages in Boreal Forests

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Possibilities to restore beetle assemblages in boreal forests were studied in a large-scale field experiment in eastern Finland with particular focus on dead-wood dependent and red-listed species. The factorial study design included 24 Scots pine dominated sites with four tree retention levels, 0, 10, 50 m^3/ha and uncut controls. Twelve of the 24 sites were burned in 2001. Thus each treatment was replicated three times. Beetles were sampled by ten flight-intercept traps per study site during the years 2000-2002, one pre-treatment year and two post-treatment years. Results of this study show the effects of different management methods on the most species rich taxa of forest dwelling species - Coleoptera. The number of red-listed and dead-wood dependent beetle species was higher on burned than on unburned sites, particularly in the second year after the treatments. Also the tree retention level affected the species assemblages. For justification of restoration of habitats it is notable, that many red-listed species were able to

find the new resources produced even in managed forests, a condition that the relevant species must meet before populations can start recovering. Although the study was conducted with logging treatments the results are widely applicable to restoration of boreal forests. Burning clearly creates resources for a number of rare and red-listed species rapidly. This is essential for continuously declining populations of many dead-wood dependent species in Finland.

Keywords: Boreal forest, Coleoptera, fire, restoration, saproxylic.

Basis of ecosystem restoration in deltas: the Ebro and Mississippi cases

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Deltas are river-dominated estuarine systems which are frequent in microtidal seas like the Mediterranean and the Gulf of Mexico. Pulsing events like river floods and marine storms strongly determine its geomorphic and ecological structure and functionning. Deltas are suffering a rapid deterioration due to human alterations of river basins (reservoirs, water abstraction and pollution, etc.) and relative sea level rise caused by global warming and subsidence. A comprehensive approach incorporating the principles of Integrated Coastal Zone Management and Integrated River Basin Management is needed to a successful and long-lasting restoration of deltaic ecosystems. Habitat restoration in deltas is strongly dependent on salinity and elevation gradients, which are determined by water and sediment pulses and fluxes from the river and sea. In the Ebro and Mississippi deltas, integrated approaches including the restoration and management of sediment fluxes in the river, the controlled distribution of freshwater and sediment pulses into the deltaic wetlands, and the use of natural and constructed wetlands to improve water quality and vertical accretion, are being developed and partially implemented. Results show that restored wetlands are only sustainable if enough vertical acretion to compensate relative sea level rise is achieved, and this is only possible when the habitats are not isolated from riverine and marine processes.

Keywords: deltas, restoration, river pulses, relative sea level rise.

A hierarchy of mitigation measures to reduce road effects on animal populations

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The construction of roads and other transportation infrastructure is a major driving force of landscape change in Europe. Animal populations are adversely affected in four ways: Roads reduce the amount and quality of habitat; act as barriers to movement, preventing animals from accessing resources on the other side of the barriers; enhance mortality due to collisions with vehicles; and break up the remaining habitat into smaller pieces. These mechanisms exhibit thresholds where populations become prone to high risk of extinction. Various mitigation measures at different scales have been suggested to reduce the effects of roads on animal populations, such as road fencing, crossing structures, reduction of traffic volumes, bundling of traffic, protection of large roadless areas, designation of areas with a high priority for road removal. This presentation suggests a hierarchy of such measures to reduce detrimental road effects based on the results of a spatially explicit individual-based model of population dynamics. Despite the German Federal Government's declared goal to "reverse the trend in land consumption and landscape fragmentation" published already in 1985, the fragmentation of landscapes in Germany has increased considerably over the last 20 years. As the critical thresholds in road density are unknown for most species and most landscape types, quantitative limits to the degree of landscape fragmentation should be established as environmental standards to curtail landscape fragmentation. A wide discussion of how to determine such limits should be started among traffic planners, ecologists, and landscape planners.

Keywords: barrier effect, ecological modelling, extinction threshold, fences, landscape fragmentation, traffic mortality.

Ecological succession and restoration of pine-oak and mixed hardwood forests in Las Joyas Research Station, Sierra de Manantlán, México

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Las Joyas Research Station (LJRS) is covered by a mosaic of mixed harwood forest, pine-oak forest and secondary shrublands. The area has a long history of anthropogenic disturbance. Studies on landscape patterns of association between vegetation and soil-land form units, disturbance history, vegetation cover change, and ecological succession were implemented to support management decisions to restore disturbed areas. Geoecological and vegetation analysis showed a positive association between hardwood forests and sites with concave soil-landform units and low disturbance; while pine-oak forests were associated with convex landforms and high disturbance. A significant increase in forest cover (from 76% to 91%) was observed between 1972 and 2000 in the 3600 ha study area; this change is related to protection of LJRS since 1986. Pine forests increased at the expense of open areas. The presence of pine-oak forests with a dense understory of hardwood tree species, in sites on concave soil-landform units, support the hypothesis that, in the absence of recurrent disturbances like wildfires, broad-leafed species will eventually replace second-growth pine stands. This hypothesis is also supported by results obtained in 12 years monitoring of permanent plots. To maintain the landscape mosaic of pine-oak and mixed hardwood forests, management of LJRS is based on a combined strategy: mixed hardwood forests, pine-oak stands with hardwoods understory and young pine-oak stands are protected from wildfire, grazing and logging to promote vegetation recovery, and prescribed burning is applied to maintain mature pine-oak stands. The landscape-based approach used to analyze vegetation relationships with soil-landform and disturbance, combined with stand dynamics studies, provide a method to make baseline and monitoring studies in protected areas management and ecological restoration projects, in many situations in which the definition of "natural" communities and human-induced conditions may be a matter of debate.

Keywords: landscape ecology, fire management, Sierra de Manantlán, soil-land form, stand dynamics.

Ecological restoration of Pulicat Lake after Tsunami, Southeast Coast of India: A Multidisciplinary approach

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On the fine morning after Christmas day the massive Tsunami ravaged the Bay of Bengal and dashed the hopes of more than 2,00,000 lives, destroying billions of dollars worth of property and rocked the fragile coastal geomorphological setting. Pulicat lake, one of the largest salt water lakes in India, is situated between $13^0\ 22^{I}\ 04^{II}$ – $13^0\ 45^{I}\ 00^{II}$ N and $80^0\ 02^{I}\ 00^{II}$ – $80^0\ 20^{I}\ 00^{II}$ E. The lake has a spread of 400 sq km with an average depth of 3 m and connected to the Bay of Bengal at the Southern tip by a small inlet of width of about 300 m. The inundation caused by the Tsunami waves have, however affected the Pulicat lake by depositing huge quantities of black clay and silt. The thickness of the clay cover may be up to 3 m. Since, the lake provides habitat, sanctuary, and food for many species of fish and wildlife and are also source of uses for humankind. Nevertheless, Tsunami brought material has threatened the existing fragile ecosystem of the lake. It is believed that more life was lost due to ingestion of this mud during the Tsunami, rather than by plain drowning. This has drastically marred the scenic ecosystem of the lake. As to why some areas suffered more than others in the lake and why some areas spread, the answer may be like in the combination of lake configuration, slope of the lake, presence of vegetation / mangroves, creation of 'shadow zone' etc. A cursory examination shows that the effects were maximum in the area where the lake cuts out in to the sea and minimum vice-versa. Presence of estuaries also lessened the impact around them since a large volume of water was taken in to the estuary by river channels. It was observed that even at 3 PM on December 26, 2004, Kalangi and Araniar estuaries which were almost stagnant with effluents were flowing into the lake as in floods. One of the most vital challenges is the restoration of complex, multi system lake representing the potential natural life. Lake Pulicat is one such ecosystem and warrants immediate restoration. Like reconciliation ecology, a matrix restoration approach recognizes the ecological value of disbursed habitats within the matrix lands between larger, preserved patches. With proper restoration management, restoration measures will be more effective than simply preserving larger, lake ecosystem settings. The insights provided by restoration ecology and matrix management suggest that restoration in Pulicat lake may be aided by creating suitable multidisciplinary shelters for habitat, ecology, and settled rural areas of the lake proper setting. This paper attempts for immediate ecosystem restoration using multi-disciplinary matrix to reverse the degradation of this important lake setup. The paper argues that institutional process should be developed to implement holistic, ecosystem based, watershed-wide, bio-sphere driven, stake-driven strategies in order to restore the

ecosystem of the lake. It is evident that whatever man has altered the natural lake setup, he has paid dearly.

Keywords: Tsunami, inundation, restoration, multi-disciplinary matrix.

The Swiss agri-environmental programme and its effects on selected biodiversity indicators

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In Switzerland, parallel to agri-environmental measures which apply directly to the field management, farmers had to convert at least 7 % of their land to ecological compensation areas – ECA. Major ECA are extensified grassland, traditional orchards, hedges, wild flower strips. In 2003, farmers practised the agri-environmental scheme all over Switzerland with a total of 119'000 hectares of different types of ECA (11% of the utilised agricultural area). The introduction of ECA throughout the agricultural area can be seen as a large scale landscape restoration experiment. This paper aims to analyse the role of ECA in promoting biodiversity at habitat and landscape scale. In three case study areas of about 6 km^2, biodiversity indicators (plants, birds, spiders, carabid beetles, grasshoppers and butterflies) were recorded in ECA and intensively managed fields between 1997 and 2004. Results showed that indicators had different reactions to ECA and scales but ECA had generally more species or different assemblages than the intensively managed fields. The most successful ECA types were the hedges and the wild flower strips. Over the period of investigation, a light positive trend of biodiversity development could be demonstrated. The impact of the ECA programme on biodiversity can globally be considered as moderate but positive because ECA contribute significantly to the regional biodiversity.

Keywords: agri-environment scheme, biodiversity, restoration, ecological compensation areas.

Effect of grazing on restoration of endangered dwarf pine (*Pinus culminicola*) in northeastern Mexico

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Fragmentation and habitat loss are the main threats to the survival of most endangered species; hence the inclusion of dynamic processes of plant communities in restoration plans would result in lower habitat loss and fragmentation. Endangered species recovery is always difficult, and we need to use the best tools, skills, and experience. The protected area “Cerro El Potosí“ is located in the Sierra Madre Oriental, northeastern of Mexico; it has an elevation of 3670 m above sea level. Due to its geographical isolation, and geological strata, it has many rare, endemic and endangered plant species. An experiment designed to test the effect of cattle, small mammals and elevation on the success of restoration of an endemic dwarf pine species was implemented. *Pinus culminicola* grows only in four high peaks in the Sierra Madre Oriental and is under pressure from grazing, wildfires and human activities such as mining, road development for timber extraction. We planted and monitored 2-year-old seedlings at three elevations within the natural distribution range of this species. At each elevation three treatments were established: (1) seedlings protected from cattle plus small mammals, (2) seedlings protected from cattle, and (3) seedlings with free access. Seedling survival was ca. 50% in (1) after four years, but there were no surviving seedlings with free access to cattle. Elevation in general did not account for variation in survival. Seedling growth was poor during the four years, which implies that seedlings remain susceptible to grazing and trampling by cattle and small mammals. The implications for a large scale restoration program are discussed.

Keywords: *Pinus culminicola,* endangered species, grazing, cattle exclosure.

Art as a Catalyst for Public Acceptance of Ecologically Designed Landscapes

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During the past decades a new landscape design aesthetic has been evolving—one that is centered on ecological health and sustainable design. Catherine Howett's (1987) essay was a call to discard romantic views of nature as manifested in picturesque landscapes and develop iconic examples for ecological interventions. Since then several researchers have discussed the aesthetic of ecological design as one that must gain public acceptance in order to have meaningful global impacts. Art has been suggested as a valuable means to help the public expand their understanding of and appreciation for ecological design approaches. This paper examines a variety of art prototypes and offers a classification of art within this genre (art/land/ecology) for the purpose of evaluating future applications. Examples of the following art types will be presented: 1) *installation*—often temporary, perhaps satirical commentaries on ecological conditions as a way to promote ecological awareness, 2) *artifact*—inclusion of design features within a landscape such as signs, benches, or sculptures that attempt to educate the public about nature and ecological issues, 3) *natural processes*—art that showcases nature's processes in attempts to sensitize viewers towards understanding temporal qualities of natural systems, 4) *community involvement*—art that directly involves the public in ecological design decision making, 5) *place making*—the artist, usually through collaboration, creates a functioning landscape with restoration or site ecology components, 6) *ecological restoration*—art and ecological restoration are one—the art is a restored landscape.

Keywords: art, eco-art, land-art, site-art, landscape ecology, ecological aesthetics.

Assemblages of wood-inhabiting fungi along the gradients of succession and naturalness in boreal pine-dominated forests in Fennoscandia

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In boreal forests, the level of naturalness and the stage of succession explain most of the variation in forest structure within a particular forest type. Thus, these two factors should also have a major effect on species assemblages in forests, at least on species groups associated with wood. The present study is the first attempt to analyze empirically the simultaneous effects of forest succession and naturalness on wood-inhabiting fungi, a taxonomic group of special ecological importance. The study area was situated in eastern Finland, middle boreal zone. A total of 41 study plots were established in *Pinus sylvestris* forests representing three levels of forest naturalness: natural, seminatural and intensively managed forests. Five stages of succession were separated according to the age of the dominating tree layer (<10, 40, 70, 110, and >150 years old), except in managed forests where only four stages were available. A total of 5,328 records of 195 species of fungi were made. The first, open stage of succession was clearly the most species-rich period of succession in all levels of forest naturalness. In natural and seminatural forests, the first stage of succession was also very distinctive in its fungal composition, and thus of special value in protecting biodiversity in boreal forests. In the succession following the first stage, the level of naturalness had more effect on assemblages of fungi than did the stage of succession. Intensive forest management affects threatened species particularly. In conclusion, natural young stages of succession should also be included and restored in the network of boreal forest reserves.

Keywords: Corticiaceae; Dead wood; Forest management; Polypores; Threatened species.

Applying Sustainable Development Principles to River Restoration in Israel

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Israel's perennial and intermittent river systems are characterized by small and highly fluctuating levels of seasonal flow carrying large amounts of pollutants. The majority originates in rural mountain regions and flow seaward through a highly urbanized landscape matrix. For years they suffered the role of neglected, abused, open sewers in the public's backyard. Since1993, the Keren Kayemeth Leisrael's Land Development Authority (KKL-LDA) has been an active partner in Israel's River Restoration Authority, playing key funding and implementation roles in numerous undertakings. River restoration projects have been found to succeed on the condition that four principles of sustainable development are fully integrated at the watershed level of

planning, execution and management: 1] *the ecological principle* (removal of pollution sources and treatment of pollutants; ecosystem restoration through strengthening of natural processes; and rehabilitation based on the river's relative strengths]; 2) *the socio-cultural principle* (encourage and strengthen stakeholder involvement; transform a public nuisance into an asset; exploit educational aspects of the project; develop heritage sites within the corridor); 3] *the economic principle* (create a climate for public demand of river corridors as an economic asset, and create investor incentives to preserve these positive features); and 4] *the intergenerational equity principle* (to provide the citizenry with continuity of access and opportunity over time). Successful projects have transformed ecological disaster areas into vital, urban, linear parkland supporting natural systems, a strong component of community identification and involvement, and economic development.

Keywords: river restoration, sustainable development, planning.

Restoration methodology of degraded areas with high species diversity and ecological succession in Brazil

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Mata Atlântica Forest – Brazil from 1,2 millions of original hectares has today only around 7% of remnant forest. Although being the most developed region in the country it is also the most degraded one. In these areas the highest priority is restoration, mainly in riparian areas, protected by our legislation, and that act as corridors of gene flow. The University of São Paulo, in Piracicaba city, São Paulo state, Brazil, established a partnership with the State Electricity Company – CESP, for the development of a programme for scientific investigation from 1988 to 2000. The basic concepts involved in the forest restoration methodology were the species diversity and the ecological succession. Budowski (1966) was used as reference to separate the tropical forest species in 4 groups, or ecological/functional groups. For restoration it was established the minimum of 100 native trees species per hectare, to represent the biodiversity. In the experiment for testing the response of the groups, it was considered that the response of plants from a group was always the same, which was confirmed later. The association of plants from different ecological groups presented very surprising results, once the nearby plants from an other group could, in many times, not compete with an individual from a specific one, and could even help in the development of this individual. During this 12 years it were developed 3 methodologies of restoration, since the most basic one, using the separation of species in the ecological groups with favorable combination among them. In the second one, it was included in the model the plant density of the species in the natural forests. In the third one, the restoration took into consideration their shape and function. During these 12 years, 500 hectares/year were planted by CESP and the cost of implementation went down from US$ 4,000 in 1988, to US$ 1,000 per hectare in 2000. In the programme of seed collection, it was used the concept of effective size (Ne) of populations and for this operation, at least 13 trees were considered, corresponding to a Ne around 50. The genetic breeding of pioneer trees species was developed for some of the most important ones, with the establishment of Seed Orchards.

Keywords: Forest restoration, tropical forest.

Adaptive Management of Wetlands in KTWR through Ecological and Participatory Approaches

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Koshi Tappu Wildlife Reserve (KTWR) is the only area of an endangered Wild Buffalo/Arna (*Bubalus bubalis* Linnn.) in Nepal, located at Koshi River floodplain-habitat in the eastern part. Recently, His Majesty's Government of Nepal/Ministry of Forests and Soil Conservation declared the peripheral area (173 km^2) of KTWR as its Buffer Zone (BZ). Traditional practice of raising excessive number of cattle (>15000) and buffalo (>5000) by certain community members around the Reserve is the other major problem of the Reserve. Sustainable alternatives that act as long term incentives are required to reduce overall domestic animal population in the area and whilst improving livelihood security for poor communities around the Reserve. Proper way of conservation and management of wetlands lying around the reserve could be the most important source of income generation through fishery. Similarly, development of community forests in the potential fallow lands of BZ, skill development training for the poorest and landless people, special packages for productive livestock and agriculture, developing fishery ponds in private and public lands, providing alternative energy, awareness program, institutional development of local User Groups/User Committees/cooperatives, special packages for women of backward communities, creating opportunities for self employment. To make the habitat trouble-free to the wildlife and

birds, ecology based management of habitat in compatible to the community development activities viz. participatory approach are the crucial tools that have been adopted by the KTWR side by side. Communities' participation has also been acquired for the better and effective management of wetlands and grasslands with respect to ecological approach. In this presentation, how these have delicate balanced in order to benefit either way will be shared and highlighted.

Keywords: wetland, floodplain, *Bubalus bubalis*

Ecological restoration or ecological rehabilitation? Towards a double vision

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In literature there is a growing attention for the role of metaphor in nature conservation. Metaphors structure how we perceive, think, and act. The metaphor of nature as a book provokes a different attitude and kind of nature management than the metaphor of nature as a machine, an organism, a network, and so on. Metaphors enable the organisation of a practice and the formation of an profession. I will explore the use of metaphors of art and medicine within the field of restoration ecology. Robert Elliot compares e.g. ecological restoration with art reproduction of art forgery whereas Andrew Light claims that it is more akin to art of restoration. Other authors however apply the metaphor of rehabilitation rather than ecological restoration. The metaphor of rehabilitation refers stronger to the domain of medicine in stead of art. While the restoration metaphor highlights structure and composition, the rehabilitation metaphor stresses process and function. Thus different metaphors express different opinions on the meaning and practise of restoration. Metaphors are important since they function as communicative devices within and between social groups or disciplines. However they are also restricted in range and in relevance. In line with the pragmatist Donald Schön I argue that we should adopt a so-called 'double vision': 'the ability to act from a frame while cultivating awareness of alternative frames'. More in particular I will argue that the adoption of such a double vision will facilitate the communication and cooperation across the boundaries that separate different kinds of nature management and groups of experts and lay people.

Keywords: metaphors, art, health, restoration, rehabilitation, communicative devices.

Applying Silvicultural Principles to Redwood Forest Restoration: A Case Study and Experiment at Redwood National Park, USA

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An abundance of young second-growth forests throughout the range of coast *Sequoia sempervirens* has encouraged a growing interest in restorative silvicultural techniques such as thinning that advance the development of old-growth forest characteristics. One of the best existing demonstrations of redwood forest restoration potential is at Redwood National Park, a World Heritage Site and Biosphere Reserve in northern California. Today these 50-year old stands typically contain more than 2,500 trees per hectare of steadily diminishing growth, and are characterized by relatively minor redwood composition, absence of understory plant diversity, and heavy fuel loads due to widespread competition-induced mortality. To remediate this condition, an ambitious forest restoration plan based on an aggressive strategy of thinning is being readied for implementation. To help guide these efforts, data from a thinning study initiated immediately after the park expansion in an even-aged upland stand of mixed redwood, *Pseudotsuga menziesii*, and *Lithocarpus densiflorus* were analyzed to determine 25-year ecosystem responses at varying thinning intensities. In the overstory, quadratic mean diameter, average conifer diameter growth, and average conifer crown ratios were all negatively related to stand densities. The proportional compositions of redwood and Douglas-fir declined substantially in the control, but were retained at constant levels by the thinning treatments. Overall, the thinned plots, while still far from old-growth, exhibit many more of the structural and compositional attributes old-growth forests than do their unthinned anlogues. Guided by these results, Redwood National Park's thinning-based restoration strategy is expected to redirect the current development trajectory of its second-growth stands from one of stagnation and degradation to one in which the acquisition of old forest features is accelerated and more certain.

Keywords: redwood, thinning, silviculture, restoration, old-growth, stand structure.

Re-creation of calcareous grasslands on ex-arable fields as habitats for endangered species in southern Germany

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Re-creation of calcareous grasslands on ex-arable fields was studied from 1993 to 2004 north of Munich, Germany. The aim of the study was to evaluate the effects of top-soil removal and hay transfer on establishment of higher plants, mosses, lichens and grasshoppers in comparison to reference sites in an adjacent nature reserve. Species-area curves showed that phanerogam and cryptogam species richness hardly differed between ancient and newly established grasslands without topsoil removal. The proportion of target species (typical plant species of dry nutrient-poor grasslands), however, was still lower on hay-transfer fields than on ancient grasslands. On newly created topsoil removal sites the number of moss species For grasshoppers, species richness was also similar to the nature reserve.

Keywords: grasslands, reference site, species richness

Developing a Grassland Rehabilitation Strategy for a Semi-Arid, Communally Owned Pastoralist Area in Kenya

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In many of the world's drylands, environmental degradation is a major ecological crisis. Particularly in developing countries, dryland degradation can lead to hardship for traditional pastoralist societies, which depend directly on these ecosystems for their livelihoods. Restoration or rehabilitation of heavily degraded drylands is often needed for pastoralist land use to be sustainable. But implementing restoration projects in communally utilized rangelands is a complex endeavor. In this paper, we present a case study of the challenges and strategies developed for grassland rehabilitation in a semi-arid region of Kenya. First, we explain some of the ecological, social, and economic problems facing Koija Group Ranch, which is owned communally by about 1,000 Laikipia Maasai people and covers about 10,000 ha of semi-arid grassland. Next, we describe our efforts to develop a community-based strategy to rehabilitate grasslands and modify land use patterns. The strategy not only stresses the value of grass for ecological benefits and grazing, but also incorporates income generation through the sale of hay bales, grass seed, and fattened stock. The project is starting at a small demonstration scale with a limited number of active participants, with the aim of gradually expanding into the rest of the Group Ranch's heavily degraded areas. While this gradual expansion strategy offers many advantages, it also raises the challenge of sharing the benefits of an initially small-scale restoration project among a large number of communal land owners. We explain the community's response to this challenge and discuss the progress of the project to date.

Keywords: rangelands, restoration, drylands, pastoralism, Kenya.

A study on the local timber distribution system in order to sustain local forest in Japan-Evaluating environmental contribution from wooden building projects

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The aim of this paper is to discuss the distribution system of local timber that can make links local building industry and forestry. In particular we focus on environmental contribution in reducing CO_2 in the air by sustaining the woods. Japan is a country in which both forestry and wood industry have long history, but Japanese forestry is not strong enough to survive in free trading circumstance of the world. The world agreement, called the Kyoto Protocol, on the other hand, does not estimates the roles of sustaining forest on absorbing CO_2. In order to enhance local forestry, environmental contribution should be estimated. Therefore we tried to evaluate the effect of sustaining the local forest, absorbing CO_2 by analyzing the local timber distribution system. To evaluate the distribution system in terms of environmental contribution, we decided to analyze an example of a private house project in which the architect decided to apply the local timbers for the project. We discuss: 1) local and global issue of wood industry and cultural aspects in Japan, 2) the local timber distribution system, 3) the case study of building process to built the wooden house, using the local timber, 4) estimating the cost balance between to sustain the local forest and to build the house in terms of the carbon amount, and 5) to estimate the possibility of wooden building projects in order to sustain local forest. Finally we discuss sustainable development by considering locality relating to the global issue.

Keywords: Sustainable Forestry, wooden building, Sustainable development, Local timber distribution system

Setting targets for restoration of degraded fen sites: is recovery of sedge-moss communities a feasible objective?

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Mesotrophic sedge-moss fens belong to the most difficult targets of the ecological restoration. The main obstacles are hydrological transformation, nutrient enrichment, problematical establishment of target plants, and unsecured future management. We develop a simple set of site-evaluation criteria, which should help assessing the feasibility of setting-up sedge-moss fens as restoration targets. It is aimed at the application of possible easy-to-measure criteria, which are suitable for rapid evaluation studies. The approach is applied to six case areas, which differ with respect to fen type and the degree of degradation. It is concluded that restoration of sedge-moss fens is undertaken only in those sites, which give best chances of success and whose restoration may contribute to a better protection of threatened species. Expensive measures, such as topsoil removal, can be realised in some areas, whose restoration is specifically important for biodiversity conservation. The sites where there are chances to apply management to restored fens should be given priority. It is likely that restoration of fen habitats will cause a withdrawal of agriculture, because of bad quality of sedge hay and difficulties to use mowing machinery and collect hay in mire conditions. In more degraded sites, restoration of wet meadows is still feasible if the aim is to contribute, in one way or another, to an increase in species richness.

Keywords: feasibility assessment, fens, Poland, restoration.

Rapid genetic identification of local provenance seed collection zones for restoration

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Use of local provenance seed for restoration is generally accepted as best practise, but guidelines on appropriate seed collection zones are lacking. We are using a DNA fingerprinting technique (AFLP), minimal sampling, and multivariate approaches to the analysis of spatial genetic variation to help delineate local genetic provenance for key species in urban bushland remnant restoration and minesite revegetation in south-west Australia. Our focus has been on Bold Park, the largest urban bushland remnant in Perth, which is the focus of a major rehabilitation program. Results for nearly 30 species to date indicate marked population genetic differentiation is typical, suggesting where possible seed should be collected from the local population to maintain genetic integrity and maximise restoration success assuming a home-site advantage. We also consider the utility of a spatial autocorrelation analysis approach to a more rapid genetic delineation of local provenance, and highlight a method for the rapid and simple communication of results to managers and restoration practitioners.

Keywords: Provenance, seed collection zones, AFLP.

Restoration of degraded forest in Tamil Nadu, India

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India occupies only 2.4% of the world's land, but its contribution to world bio diversity is approximately 8% of the total number of species. Tamil Nadu is one of the biologically rich state in India. The states total forest area including tree cover is 27,536 sq. km, which constitutes 3.6% of the country Forest and Tree cover. There are many forest types in Tamil Nadu spread within the Western Ghats, Eastern Ghats and Coastal plains. The Research wing of the Tamil Nadu Forest Department was established in 1918. The research wing conducts research in many thrust areas like Bio diversity conservation, Medicinal plant conservation, Post harvest technology, Agro forestry, Silviculture, Seed Biology, Soil nutrient management, Organic Tree husbandry and Restoration ecology. Restoration ecology is an important thrust area in which the research wing has been concentrating effectively. The restoration efforts of sand dune areas, coastal areas, mangrove forest and degraded forest types namely Dry deciduous, Tropical dry evergreen forest are

success stories. Restoration has been possible with convergent research technology applications and effective conservation strategies. The strategies for restoration differ from forest type to forest type. Restoration of degraded hillock areas has been a long time effort of the Tamil Nadu Forest Department. However, restoration is not complete if all the original floristic elements available in the tract are not reintroduced. Reintroduction with native species has always witnessed difficulties due to the growing biotic pressures. Restoration of degraded hills calls for combination of strategies, which involves studies on Flora, Fauna, Organic soil matter, Biotic pressures, appropriate water conservation models and detailed study on ecological succession. This paper will in particular discuss on strategies adopted for Restoration of degraded Hillocks in Tamil Nadu both in Eastern and Western Ghats of Tamil Nadu, India.

Keywords: dry, biodiversity, restoration, native species, India.

Restoration of West Coast of Renosterveld: is the restoration of a highly fragmented vegetation worth the effort?

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The lowland vegetation of the Western Cape, South Africa, has been extensively transformed by human intervention over centuries, ranging from agricultural conversion, urbanisation to mining, and leaving less than 10% of the extent of the original vegetation. In the case of coastal renosterveld, a Mediterranean shrubland associated with fertile soils, and a rainfall regime suitable for agriculture, less than three percent of the original extent remains. The remaining natural habitat fragments are isolated, situated within a matrix of agricultural and urban areas, and the vegetation within the remnants is often severely degraded and threatened by the invasion of alien species. Many of these vegetation remnants are situated on private lands still used for agriculture, and are not sufficiently protected. However, in a shift of priorities, many farmers and landowners show an interest in conservation, and are investigating ways to protect the vegetation, and to restore renosterveld in abandoned agricultural areas. This provides an opportunity to incorporate these previously transformed and unprotected areas in the existing conservation network where they can fulfil an important role as corridors or additional habitat. Research has shown that the natural return of the indigenous vegetation to abandoned fields is limited, and even after decades of abandonment, and close proximity to natural vegetation, indigenous species seem to be unable to establish in these areas. Re-colonisation seems to be limited by a number of factors, like changes in soil chemistry, seed dispersal properties of indigenous species, and competition from alien species. In addition, due to transformation and the high degree of fragmentation, many ecological processes are severely interrupted, and it is questionable whether these can be re-instated without active management. Management options for renosterveld range from burning over brush cutting to grazing by indigenous large herbivores or even domesticated animals, and the initial application of herbicides to “kick-start” the natural re-colonisation process. Next to actual restoration and management processes and procedures, I will discuss possible usages and their economic value of the restored areas of renosterveld.

Keywords: Mediterranean shrubland, restoration, management strategies, economic valuation.

Restoring degraded landscapes or building resilience? Two case studies from inland Australia

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It is always difficult to overcome degradation in dryland areas because of the limitation on plant growth imposed by water shortages. This difficulty is accentuated in most parts of inland Australia by the large year-to-year variability in rainfall. I shall describe attempts to undertake restoration at two contrasting field situations. One is at a site where degradation was caused by overgrazing and the other is at mine-site. The two cases differ in the degree of degradation and in the resources available to undertake restoration. Restoration efforts have been underway at both sites for around 10 years and I will describe the approaches used over that period. In both cases only limited amounts of the original biodiversity have been restored by the treatments applied. On the other hand, there is evidence at one site that some of the key ecosystem processes are being re-established and that resilience has been enhanced. Where this occurs, some biodiversity restoration may be eventually possible in the longer term. I will explore some of these potential longer-term outcomes and review some of the implications these findings may have for developing ways of overcoming degradation in these arid and semi-arid areas.

Keywords: dryland areas, Australia, restoration.

Modelling progressive sediment check-dam removal to restore a damaged ecosystem without brutal disruption of sediment balance – Adaptation of the resulting structure to flood mitigation.

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The 8 km^2 mountainous Isepnica cachment in Poland is a study-site where the efficiency of small structures to mitigate floods with limited side-impacts on the ecosystem are tested. However, two previously existing 8 and 7 meter-high sediment checkdams are dangerously damaged and should be dismantled. Besides, they prevent migrations and are now inefficient because sediments have totally filled them up. Because of this enormous volume of compacted sediment, destroying the dams in one operation would be unrealistic, costly, and would suddenly release sediment into the stream. We therefore propose a gradual removal, by lowering the overspill by stages. Moreover, the main structure can be kept and adapted afterwards for flood mitigation purposes. Numerical simulation were carried out to forecast sediment removal for different scenarios of overspill lowering. The effect of several floods, from moderate to rare, is tested at each stage. Modelling also established the influence of the overspill level on the intensity of riverbed erosion downstream. The one–dimensional sediment transport model RubarBe, developed by Cemagref, was used to estimate the quantity of sediments transported by balancing inputs, outputs and exchanges with the bottom. Particularly in mountain rivers, one flood may significantly change the morphology of the river bed. It implies that the model had to integrate unsteady flow and cross sections changes with time. A gradual decommissioning strategy is subsequently proposed to ensure a safe transition towards a final state improving the stream status. Our recommendations include river corridor restoration measures, and transformation of the structures into dry reservoirs blending with the mountainous landscape.

Keywords: Sediment check-dams, Dam decommissioning, Flood mitigation, Stream restoration.

Progress and Challenges in the Restoration of Fitzroya cupressoides in Southern Chile

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Fitzroya cupressoides is a long-lived threatened conifer endemic to Chile and adjacent Argentina. Since 1998 about 12 second growth populations <2 ha have been identified as the only surviving populations in the Central Depression of Chile. Recent studies have demonstrated that these populations are genetically different than those growing in disjunct areas in the Andean and the Coastal Ranges, therefore having a high priority for conservation and restoration. In Since 1998 we have been conducting small-scale restoration experiences in partnership with a small private land owner and with a Provincial Park, on a total area of 5 ha. We planted seedlings and cuttings from local populations in order to promote the conservation of the local genotypes. The experiences in both sites have been successful, with survival rates >75% after 7 years. Monitoring of these plantations indicate mean annual growth rates of 10.3 cm and 4.4 cm in the two sites, respectively. This restoration experience has provided valuable scientific information, as well as education and outreach opportunities for other small land owners with other threatened endemic species in Chile. It has also inspired new restoration efforts with *Fitzroya* involving larger areas. Future challenges involve the improvement of restoration techniques for *Fitzroya* (e.g. follow up cone induction experiments), the development of techniques for the restoration of other species, involvement of a larger number of owners, and the use of afforestation subsidies for these activities. A final challenge is the need of integration of technical, economic, social and cultural aspects in our restoration efforts.

Keywords: *Fitzroya*, peatbog, restoration, small land-owners.

An evaluation on the effects of rehabilitation practiced in the coal mining spoils in Korea

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The effects of rehabilitation carried out in several sites, which are different in elevation and kinds of plants introduced, were evaluated in viewpoints of species composition, species diversity and physicochemical properties of soil. Black locust, pitch pine, birch etc. were introduced for rehabilitation. Species

composition of the rehabilitated sites showed somewhat difference from that of the natural forests without any relationship to elevation of sites and kinds of plants introduced. But species composition of the sites, which were restored naturally, was very similar to that of the natural site. Korean red pine and birch were usually immigrated naturally in the coal mining spoils of lowland and upland, respectively. Species diversity of the rehabilitated sites usually increased. Degree of diversity depended on history of rehabilitation. Physico-chemical properties of substrate showed big differences compared with those of the natural sites. For example, substrate of the coal mining spoils showed strong acidic property and nutrient deficiency. Those physico-chemical properties of substrate hardly changed depending on the period after rehabilitation. Therefore, above mentioned results were hard to be interpreted as the successional changes and the practices did not realize an ecological restoration. New method based on the ecological information obtained from the natural environment equipped with similar condition is under experimental study in order to solve the problems.

Keywords: ecological restoration, rehabilitation, species composition, species diversity, successional change.

Effects of different planting techniques to the structural diversity of restored forests in urban area

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We surveyed the differences of forest development process on two 0.5 ha forest stands restored by different planting techniques. Floristic composition, structural attributes, light condition, soil characteristics, and bird distribution were investigated on 23-year-old forests, located on newly reclaimed seaside land in central Japan. Two forest stands under the almost same geographical conditions had significant differences in the parameters of floristic diversity and structure after 23-year of plantation. One forest stand with diverse planting species and higher planting density showed markedly higher tree species diversity, tree density, and litter layer depth and the other with high planting density of tall tree species and low density of small tree species presented greater mean tree size and simpler undercanopy structure. In additions, big differences of dominant seedling species and successional patterns were also detected. Structurally well developed stand showed higher dominance of native forest species and self sustainability and structurally simple stand presented higher dominance of exotic and early-seral-stage species and declination of undercanopy vegetation. These differences may be the results of the different planting techniques including the selection of planting species and density. Structural diversity of planted forest appears to influence not only the composition of floor vegetation but also the successional pattern. In particular, undercanopy vegetation plays a key role in maintaining both floristic diversity and self-sustainability of restored forests in urban areas. Therefore, the planting techniques focusing on the structural diversity of undercanopy vegetation would be desirable for the restoration of native forests in urban areas.

Keywords: Forest restoration, reclaimed seaside land, planting techniques, structural diversity.

Monitoring of the evolution of *Spartina maritima* marshes created through transplant in tidal mudflats of the Odiel estuary (Huelva, SW Spain)

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The cordgrass *Spartina maritima* (Curtis) Fernald is a primary colonizer of low intertidal mudflats in salt marshes of the European Atlantic coast. Its high tolerance to long daily flooding periods and low oxygen levels in the sediment allow it to facilitate the succession process. Two major concerns for the conservation of its populations are competition with the invader *Spartina densiflora* Brong. and habitat loss as a consequence of accelerated erosion. Since 1997 our group has carried out 9 transplant experiments (m^2), using plants from natural populations of the Odiel estuary to create new marshes in previously unvegetated tidal mudflats. Our work aimed to assess the evolution of *Spartina maritima* created marshes through the monitoring of abiotic and biotic environmental factors: topography, conductivity, redox potential, pH, organic matter content and density and height of tillers, below- and above-ground biomass of *S. maritima* and presence of other species. Sampling on populations growing from transplants carried out in different years provided a diachronic approach to their evolution. These results from marshes created by transplants were compared to those obtained form natural *S. maritima* populations and unvegetated low-marsh areas.

Keywords: marsh creation, *Spartina maritima,* transplants, erosion, Odiel estuary.

Evaluating different forest restoration techniques in Southern Finland

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As a result of intensive silvicultural policies during last 50 years the structure of Finnish forests has changed dramatically leading to even-structured stands with a low amount of coarse woody debris (CWD). Also the proportion of economically less valuable trees like most of the deciduous trees. Even conservation areas in Southern Finland consist mainly of old commercial forests and thus mainly have this unnatural forest structure. These structural changes have effected the forest biodiversity and are the main cause of endangerment of several threatened species dependant e.g of CWD and/or old deciduous trees as aspen. In recent years several restoration techniques are introduced in order to improve the biodiversity characteristics by starting the natural succession mainly by restoration burnings, improving the characteristics favoring deciduous trees e.g by creating small gaps and increasing the amount of CWD by felling and girdling. In order to compare the effectivity and suitability of different methods research is needed. In Evo experimental area in Southern Finland ecological responses of e.g restoration burnings with different retention are monitored with several organism groups (vascular plants, bryophytes, coleoptera, polypores). Also the population structure of key tree species as aspen is estimated and the techniques attempting to increase aspen are monitored. Preliminary results show that with restoration burnings biodiversity can be promoted by increasing charred wood and CWD in general which are limiting factors for several species. The current demographic structure of aspen combined to browsing effect of moose lead to scenarios where aspen populations in conservation areas are gradually decreasing. The browsing can be at least partly prevented by fencing and thus ensure the surviving of saplings.

Keywords: forest restoration, prescribed burning, aspen, CWD.

Species diversity of reforested communities after the removal of invasive weed, Crofton (*Eupatorium adenophorum* Spreng.) in middle Yunnan, SW China

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Crofton weed (*Eupatorium adenophorum* Spreng) is a harmful noxious weed in southwestern China. In this paper, the structure, species composition and plant diversity of reforested communities after removal invasive crofton that occurred at the beginning of the 1980s, and the local old growth forest of *Pinus yunnanensis* as well as uncontrolled crofton invasive land were surveyed in middle Yunnan, southwestern China in 2003. The results showed that the values of Richness index (*R*), Shannon-Wiener index (*H*), Simpson index (*D*) and Pielou evenness index (*J*) of the woody species in the reforested communities were 25-28, 1.06-2.34, 0.36-0.86 and 0.32-0.73, the herb species were 6-8, 1.51-1.97, 0.74-0.84, 0.84-0.90, respectively. The corresponding indices of woody species in the crofton community were only 3£¨0.14£¨0.10, 0.13, and the herb species were 3, 0.09, 0.03, 0.08, which were obvious lower than the restored forest communities. It indicated that the restored communities dominated by fast growing tree species had well developed through a rehabilitation period of 20 years. There were clear understory layer dominated by native species under the restored forest communities. The density and growth rate of the crofton have been inhibited and plant diversity has greatly increased in restored communities in comparison with the crofton community. *Pinus yunnanensis* + *Schima wallichii* + *Eucalyptus globules* community had the greatest plant diversity among the restored forest communities. However, at present the reforested communities was lower than that of the old growth forest of *P. yunnanensis*, having the values *R, H, D* and *J* of 42, 2.88, 0.92 and 0.77 of woody species, and 8, 2.08, 0.86 and 0.90 of herb species, respectively. It was suggested that more attention should be paid to conservation of the restored communities, especially for the *P. yunnanensis* plantation built on the degraded lands invaded by the crofton. In addition, introduction of local broad-leaved species and some shade-loving herb plants into these reforested communities and follow-up management are also important for the sustainable development of the revegetation.

Keywords: Species diversity, invasive species, vegetation restoration, SW China.

Evaluating roadside restoration practices and plant composition in urban zones

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The practice of revegetation can play a vital role in restoring native vegetation to disturbed ecosystems such as roadsides. This study evaluated success of vegetation establishment on revegetated roadsides in Tucson, AZ. Species richness, origin, cover, density and structural diversity were measured for 25 distinct revegetation sites located along various roadways in Tucson, AZ. Comparisons were done between existing vegetation and specifications of the revegetation plan for the site. Results indicated that the majority of species established were not specified in the original revegetation plan. The presentation will focus on discussion of species composition for the sites and effective revegetation practices for establishment of native vegetation in this region. Recommendations related to appropriate practices and plant species for future urban development and remediation in Tucson will also be emphasized.

Keywords: revegetation, roadsides, native vegetation.

Differential effects of increased sulphate concentrations on the restoration of riverine wetlands; the role of sediment type

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Restoration of riverine wetlands is one of the targets going well together with river safety policies. However, both river water quality and sediment quality determine the possibilities for nature development, as related to biogeochemical processes, such as the formation of floating peat fens. We tested the effects of river water pollution with sulphate in a laboratory study with three types of sediment from floodplains of the river Meuse: an iron-poor floating peat fen, an iron-rich organic soil from an alder carr and an iron-rich clay soil poor in organic matter. Sediments were flooded in aquaria with or without sulphate pollution, and potential methane and carbon dioxide production were measured. Sulphate pollution caused production of sulphide to phytotoxic levels only in the iron-poor organic sediment. It also hampered methane production, necessary for buoyancy of floating fens. The presence of high concentrations of iron serving as a more favourable electron acceptor had the same effect on methane production. In the clay sediment the production of both gasses was limited by the availability of organic matter. Sulphate pollution decreased the iron concentration in soil pore water in the iron rich organic sediment and caused a slightly higher P concentration in the soil pore water in this sediment, showing the risks for eutrophication. The observed differential responses will be discussed in relation to restoration prospects for different sediment types in riverine wetlands.

Keywords: riverine wetlands, sulphate pollution, methane production, eutrophication.

Ecological singularity of roadscapes: Do plants perceive the difference between natural and man-made slopes?

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According to the Ministry of Civil Works, the road density in Spain is 0.33 Km/Km^2. Therefore, the total surface in road slopes nearly reaches 5.000 Km^2. That is, ten times the size of Doñana, the most emblematic Spanish National Park. Despite its relevance, this man-made environment lacks of a reference ecological model. We hypothesize that ecosystem structure and functioning in roadsides significantly differ not only from those in the surrounding environment, but even from the paradigm of natural slopes. At the population level, the response of *Dactylis glomerata* L. to light environment, characterized by hemi-spherical photograph analysis, significantly differed between natural and roadside slopes. Differences were also found between plants from roadfills and roadcuts, in photoprotective pigment content (VAZ and ß-carotene) and particularly in SPAD units, likely indicating a lower nitrogen availability in roadcuts. At the community level, the roadside flora of Madrid (Central Spain) comprises some 385 species and is characterized by the dominance of annual, wind-dispersed, entomophilous or autogamous, ruderals of *Asteraceae, Poaceae, Fabaceae* and *Brassicaceae*. Mediterranean taxa prevailed over cosmopolite species. Roadscape distinctiveness seems to persist over decades, although current restoration protocols aim landscape integration. In a collaborative effort between a

building company and a research institution, we have equipped an 8.300 m^2 experimental field across roadcuts and roadfills to monitor environmental dynamics. The interaction between hydroseeding with different mixtures and spontaneous plant colonization and recruitment is tracked in plots where climatic and edaphic conditions are monitored by stations, microestations, erosion pins and periodic soil sampling.

Keywords: Emerging ecosystems, roadfills, roadcuts, hydroseeding.

Genetic variation of *Quercus suber*: a tool for regeneration of cork oak woodlands

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Cork oak trees are an essential element in the agro-ecosystems of the Iberian Peninsula, supporting rich wildlife populations and simultaneously producing 80% of mean annual cork world production. Nowadays these forest ecosystems are threatened by climatic changes that may enhance water deficits, and by regional land use changes resulting in a continuous degradation of the soil, the aggression of pathogenic agents and an increased frequency of forest fires. Despite their ecological and socio-economic importance, cork oak adaptability to environmental conditions is poorly understood. Not only established stands may be prone to tree mortality, but the current reforestation effort may be jeopardized by the use of unsuitable genetic material leading to low survival rates. In order to evaluate the genetic resources of cork oak, we established, in 1998, in Portugal a multi-locality provenance trial in three sites, as part of an Euforgen network. 35 populations from the natural cork oak (*Quercus suber* sp.) distribution area are represented. Population's adaptability was evaluated in two sites through survival, growth, water use efficiency and timing of bud burst. Genetic diversity was also assessed, using nuclear and chloroplast DNA. As in similar studies with this species, we observed low level of differentiation among populations. However, significant differences between populations were observed for survival, growth and bud burst. French populations revealed the lowest survival in both sites. Moroccan populations are generally higher than the others. Eastern populations were the earliest to reach bud burst whereas the western were the latest ones.

Keywords: cork oak, genetic variability, adaptability, *Quercus suber*.

What are the alternatives to restoration of thicket vegetation at development sites along the eastern cape (South African) coast?

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Development for resorts, industry and townships in the Eastern Cape has resulted in the loss of many of the species-rich dune and valley thicket. Many of the plant species of thicket are bulbous and succulent species, which can be rescued (salvaged) from planned development sites and used in restoration. This study shows that, although there is good success in the survival of rescued species, there are a number of problems in restoration. When compared with the original thicket species composition, only a limited number of species can be rescued. Many species of trees, shrubs, lianas and herbs would have to be regrown from seeds or cuttings with limited success in establishing a sufficient plant base for the rehabilitation. It is difficult to reconstitute the exact species composition and complex physiognomic structure of thicket. Rehabilitated areas will therefore always appear to be artificial. This paper considers alternatives to restoration so as to limit the amount of destruction of thicket vegetation during development. These include design and construction of resorts and townships with least destruction to the sites and the restoration of thicket in the disturbed areas around houses or along roads, sewerage and pipelines, etc. Finally, important alternative types of development design are discussed, which are in harmony with the environment and will preserve thicket sites of great conservation importance.

Keywords: species-rich, restoration, thicket vegetation.

Biogeochemical constraints for restoration of sulphate-rich freshwater wetlands

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In Europe, sulphate concentrations in groundwater have generally increased as a consequence of increased drought and leaching of nitrate from agricultural lands, both favouring the oxidation of geological pyrite in the subsoil. Under certain conditions, this can lead to phosphate mobilisation in the sediment of groundwater fed wetlands, as produced sulphide interacts with the iron cycle due to formation of FeS_x. The aim of this study is to describe the biogeochemical processes in sulphate-rich wetlands and the problems and constraints involved in restoration of desiccated wetlands. Monitoring data on restoration projects show that simple retention of surface water, via permanent damming of drainage ditches, leads to further decline of the endangered vegetation and to vigorous growth of lemnids and fast growing wetland grasses. Permanent high water tables alter the hydrology of wetlands by blocking groundwater input and by preventing periodic drought during summer. Laboratory and field experiments indicate that high stagnating water tables lower the redox potential in the sediment stimulating sulphate reduction. In addition, the absence of periodic drought in summer prevents regeneration of phosphate-binding iron, as no FeS_x is oxidised in the sediment top layer any longer. These processes, together with the blocked discharge of iron- and calcium-rich groundwater, lead to iron depletion and concomitant mobilisation of phosphate in the sediment and overlying water layer, a process called internal eutrophication. These processes must be taken into account in wetland restoration projcets as also appears from successful projects that also will be discussed.

Keywords: eutrophication, hydrology, restoration, sulphate, wetlands.

Naturalness, a feasible target in ecological restoration. How to measure it

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The concept of naturalness both as a conservation value and as a descriptor of ecosystem state is presented. The latter can be used in many conservation activity fields, and particularly in restoration ecology, which should aim to push systems from a less natural to a more natural state. Therefore, there is a need to somehow "measure" naturalness. The index of naturalness developed by the author in 2004 will be shortly presented. It is strongly focused on its practical application. The index ranks from a maximum of naturalness [10] to a minimum of [0] (artificial systems). By fixing the present state index of a given system, a higher index can be set as a target for restoration (for instance: from 5 to 7). Its ecological foundation (system analysis), diagnostic criteria and application procedures (mapping included) is summarized, and some mapping examples and naturalness profiles taken from different working scales are presented.

Keywords: ecological restoration, naturalness, index, scale.

The Human Ecosystem as an Organizing Concept in Ecosystem Restoration

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The restoration of severely disturbed ecosystems represents one of conservation's grand challenges in the 21st century. Restoration is particularly complex when ecosystems have been significantly disturbed and the related social, political, and economic systems have likewise been substantively (and negatively) transformed. Examples include landscapes impacted by industrial plunder (such as selected mining/timbering regions), military control (such as large-scale bombing ranges), rampant land speculation (leading to sprawl), urban decline, and more. In such cases, interdisciplinary models for restoration and conservation practice become critically important. The human ecosystem is proposed as an organizing concept in ecosystem restoration, and a specific human ecosystem model is presented that describes the critical linkages between biophysical and sociocultural variables. The model includes a set of essential variables, including base conditions, critical resources, social institutions, timing cycles, and key flows. The model is primarily useful for predicting and evaluating cascading and non-linear first-, second-, and third-order effects, and is capable of synthesizing a large range of theory, method, and evidence. Application of the model to complex restoration challenges is potentially useful. One such challenge is "swords to plowshares" restoration of sites formerly used for military training, storage, and operations. An example is the restoration of Vieques, Puerto Rico—an island used by the US Navy since WWII for extensive military training, and recently returned to civilian use and conservation. The model also has potential application

in other kinds of restoration efforts underway in such places as post-war Kosovo, South Florida, the Iraqi marshlands, and elsewhere.

Keywords: human ecosystem, model, restoration, social systems

The peoples of traditional cultures as indicators and keepers of the natural ecosystems

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The peoples of traditional cultures, or persistent peoples, demonstrate their "harmony" with nature. In Russia about 20 nationalities of North, Siberia and Far East belong to this category. The whole size of their population is somewhere about 200000 of persons. They populate enormous areas of tundra, boreal forests, river- and seacoasts. In comparison with others their population density is very low. During long time persistent peoples keep "perfect" natural self-supporting economy, constant population size and have "not been developing". They "blend" with biocoenoses of "inhabited landscapes" and preserve "feeding ecosystems". Keeping semi-nomadic mode of life they consume the products of fishing, hunting, reindeer breeding and timber in restricted quantities. They utilize the natural products completely and almost do not make wastes. The division of labour is just within bounds of a family. Such nationalities have simple social structure and no excess of free energy (exergy) for the growth of population, landscape transformation, the increase in well-being or self-development, for all that they had in their historical past. The applying of widespread social standards (social aid, the increase in material well-being, lifetime prolongation, usage of technical achievements) to persistent ethnoses as well as their involvement in trade exchange bring about the damage and destabilisation of "feeding ecosystems" as the result of overgrazing, overhunting, overfishing and the loss of nature usage skills. Ethno-cultural (national) parks creation would be reasonable for the maintenance of economy, technologies and methods of managing of persistent peoples as the top elements of natural ecosistems, their indicators and keepers.

Keywords: feeding ecosystems, fishing, hunting, reindeer breeding, natural self-supporting economy, social structure, national parks.

Contribution of genetic tools to an integrated approach for ecological restoration in the French Pyrenees: from science to seed production

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In the context of the conservation of the native flora, the Pyrenean Botanic Conservatory was interested in developing a multidisciplinary approach of ecological restoration of damaged sites in the French Pyrenees. The project began as a clear necessity for Pyrenees National Park in the early 80's, in the laying out of touristic sites in its area of influence. This kind of action was then extend to the whole Pyrenean chain, with a concrete project of seed production, and a technical, scientific and legislative organization to support seed utilization. During seven years, we have been exploring socio-economical aspects, biological and ecological data, agronomic parameters and genetic structuration to go towards the organization of seed production. Our goal was to give land managers the tools to perform ecological restoration of damaged sites at sub-alpine and alpine level. We present, as an example, the approach linking technical, ecological, biological, agronomic and genetic results of one species (*Rumex scutatus*), to ensure seed production and seed utilization in the respect of precaution principle. The synthesis of all these studies lead us to the definition of zones of "collect and use", that have to be maintained as different geographic origins for the use of this native species in land reclamation in the French Pyrenees.

Keywords: Mountain damaged sites, land reclamation, geographic origins, phylogeography, *Rumex scutatus*.

The use of GIS in the Restoration of Woodlands'ecosystems in the Semi-arid region of Iran (A case study in Tehran)

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The lack of afforestation and green areas in the semi-arid region of Iran most important environmental problems nowadays .Regarding to the lack of suitable spaces for afforesting and green areas' development especially inside the semi-arid region, the managers have been developed the green areas in the form of green belts at the outskirts of Tehran which in addition to the environmental benefits in restoring the ecosystem of forest park and woodlands, they will prevent the cities from being horizontally extended. Another important subject in the restoration of woodlands' ecosystem apart from the type of land, is the types of suitable resistant plant species which will be selected on the basis of land capability. For assigning the land capability on the basis of using land-use planning principles and the use of a variety of information that relates to the land ,it is necessary to use the best and suitable land-use models. Regarding to the variety and the huge amount of information and the necessity of data analyzing, the use of GIS is inevitable. The Khojeer woodland is located in the east of Tehran with Semi-arid climate.To classify the khojeer woodland region from the intensity of needed restoration treatments,firstly, all the regions' base maps such as Soil, Geomorphology, Geology, Lithology,Soil erodibility, Plantation, Hight ,Slope and Aspect were produced and according to the land –use Planning Principles, They were overlayed in the GIS environment for producing the region's map of ecological units .On the other hand. The region's model of ecological capabilities for restoration was suggested. Finally, this model was coded in GIS environment and applied on the map of ecological units and at last the map of region's ecological capabilities for needed restoration treatments' intensity was produced. At the second part of our research, some resistant tree species were suggested for restoring the woodland's ecosystem through reforestation and afforestation techniques.

Keywords: *Afforestation,restoration,woodlands,Land-use planning,GIS.*

Restoration of endemic and threatened freshwater fishes and their habitats in the western ghats, India

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A study was conducted to evaluate the information on the diversity, distribution and current conservation status of freshwater fishes in the Nilgiri Biosphere Reserve (NBR), Western ghats, southern India. A total of 117 species belonging to 7 orders, 20 families and 50 genera from 75 sites in the east flowing and west flowing river systems were collected; of which, 30 species are endemic to the Western Ghats and 19 species are endemic to the Nilgiri Biosphere Reserve. The maximum species richness, diversity and dominance were observed in the Kabini river basin followed by the Moyar, Bhavani, Chaliyar and Bharathapuzha river basins. The current conservation status was assessed based on the species richness, abundance, threats to the species and habitat quality. Out of the 117 species recorded, 12 species are Critically Endangered, 22 species are Endangered, 33 species are Vulnerable, 27 species are Low risk - near threatened and 17 species as Low risk - least concern. *In situ* conservation, captive breeding programmes, habitat protection and restoration, fish sanctuary, protecting and developing riparian vegetation, banning of sand collection from the river and river banks, completely banning fish capture during the breeding season, and creating awareness among the local tribal people about the importance and sustainable uses of these fishes are suggested as conservation measures. Based on the earlier study, the endemic and threatened freshwater fishes and their habitats will be identified for restoration. The proposed restoration study will help to conserve the endemic and critically endangered fish species and their habitat from extinction as well as help the socio economic status of the local fishing community. Most of the Tor group species of fishes grow to a weight of more than 50 kg within 3-4 years time. This wild population will maintain the germplasm resource for conservation. The purpose of the study is to collect and stock endemic and threatened fishes in the wild for breeding programmes. Habitat assessments will form a major part of the initial programme, followed by a comprehensive breeding programme.

Keywords: Conservation, endemic and threatened fishes, restoration.

Ecological restoration of oak species in southern Spain: climatic distribution and ecological responses

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Many afforestation programs of degraded or burned forest areas, and abandoned croplands, are currently taking place in southern Spain. A common question is: What species are suitable and where should be planted, in order to restore Mediterranean forests? In this paper we present some results of the integrated research project Heteromed. Firstly, we analyse the distribution of oak species in southern Spain, based on the Second National Forest Inventory, and examine their relationships with climatic and edaphic variables. Secondly, we compile the available information about seed production, predation rate, emergence and establishment of seedlings for several oak species in different types of habitats, and evaluate their connection with environmental variables at different spatial scales. Thirdly, we compile ecophysiological information about leaf features (SLA, chemical composition), photosynthesis and respiration rates, and relative growth rates of the different oak species, responding to contrasted conditions of light and water, both in field and glasshouse experiments. We propose that the selection of oak species should follow an integrated criterion, including not only their actual climatic and edaphic conditions, but also the local heterogeneity of microhabitats, the conditional outcomes of plant-plant (competition vs. facilitation) and plant-animal (mutualism vs. antagonism) interactions, and the ecological and ecophysiological responses of the different species. In addition, historical evidences about their past distribution before the strong human disturbance by fire and overgrazing, and foreseen scenarios of global change should be incorporated to the restoration program.

Keywords: *Quercus spp.*, Mediterranean forest, regeneration ecology, ecophysiology.

IGF: A tool for evaluating geomorphologic integrity in river restoration projects

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The IGF has been developed as an index to evaluate geomorphologic condition and impacts on fluvial systems. This tool can be applied in rapid ecological assessment, environmental impact assessment and river restoration monitoring. IGF has been designed for a hierarchical and objectives-oriented evaluation procedure. Its application is based on the definition of objectives and scale of evaluation. It includes deep characterization and diagnosis to allow a proper evaluation. Geomorphologic condition is evaluated in four axes: vertical profile, degree of freedom, cross section and sedimentary dynamic using different metrics depending on river type. There are two available scales of evaluation that comprise most used working scales in river restoration: fluvial segment and fluvial reach. Features for IGF evaluation at fluvial segment scale are based mainly on aerial photographs and DEM analysis, while at reach scale, IGF evaluation is based on fieldwork. IGF has been applied to analyze geomorphologic status for pre and post restoration scenarios on a fluvial reach in Jarama River Basin. The studied reach is located in an alluvial segment of Jarama River, affected by agriculture and gravel mining. Pre-restoration scenarios showed impacts due to restrictions of lateral movement, banks instability and the alteration of natural sedimentary dynamics. Results have shown that IGF is sensitive to changes in fluvial geomorphology related to restoration activities. IGF has proved to be a good indicator of the degree of success in restoration projects. We propose the extent of IGF application in different ecotypes and watersheds, to check its performance under different conditions.

Keywords: fluvial geomorphology, ecological status, rivers, restoration.

Wetland restoration: Techniques that work

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This paper provides examples from the United States of America on successful wetland restoration projects I have designed and constructed over the past 20 years. These projects range in size from 500 square meters, to over 15 hectares in area. Examples include project sites where contaminated soils have been removed and the wetlands re-built in the same location; highway and infrastructure projects; river

and streambank restoration; hydro-electric projects; and mitigation for industrial and commercial development. Smaller wetland restoration areas are often more difficult to create than larger areas. Proper hydrology is the principal factor dictating the success or failure of a wetland restoration area; however soil composition, soil fertility, construction techniques, time of the year, plant materials and sources, and post construction monitoring are all critical factors which influence the final success of the wetland restoration. Post construction monitoring of wetland restoration sites has demonstrated that the long-term control of invasive species is an important factor in contributing to the ultimate success of wetland restoration with native species. This paper provides practical information on how to insure the success of wetland restoration projects.

Keywords: Wetland, Restoration, River.

Efficiency of sludge application as an amendment for the restoration of shrub-grassland ecosystems on mine soils polluted by heavy metals.

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In order to evaluate the interest of the application of sewage sludge as an amendment for the remediation of mine soils with scarce organic matter content and polluted mainly by Pb, Zn and Cd, a microcosm bioassay was carried out (30 weeks). Three different cases were compared: (i) mine soil without sludge addition, (ii) soil plus 100 Tn/ha sludge and (iii) soil plus 200 Tn/ha of sludge. Plant biodiversity, biomass and soil coverage were measured, as well as Ca, Na, Mg, K, Cu, Fe, Mn, Zn, Al, Cd, Ni and Pb contents in soils and plants, and pH and organic matter in the soils. Both doses of sludge improved significantly soil´s fertility, as well as the vigour of the plants, which presented a higher soil coverage in sludge-treated soils, and a trend to increase their biomass. The mobility of some elements (Fe, Mn, Mg) in the soil increased at the end of the assay in the treatments where sludge was applied (which was likely due to a decrease in pH caused by the sludge) but, on the other hand, more toxic elements were stabilised by adsorption to the sludge organic matter (Zn) or by accumulation in the subterranean parts of the vegetation (Pb). These results lead us to think that this sludge used could be useful for the ecological restoration of land ecosystems with this kind of pollution. Moreover, the use of sludge for ecosystem rehabilitation could also be a good alternative for the management of these wastes. Acknowledgements: Project REN2002-02501/TECNO of MCyT.

Keywords: sludge, heavy metal pollution, fertility improvement, remediation, phytostabilization.

Using Ecological Theory to Plan Restorations of Endangered Species in Fragmented Habitats

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Population viability and metapopulation models are heuristic tools that can be used to plan restorations and assess their success. Generalizations from theory can guide decisions about experimental designs used for restorations. Using examples from South Florida, U.S.A., I review ongoing restoration experiments with the federally endangered coastal perennial vine, beach jacquemontia, *Jacquemontia reclinata.* Nine wild populations are declining in isolated habitat fragments varying in size, occupied area, and degree of isolation. Eleven reintroduction sites ranging in size from 422 m^2 to 4800 m^2 within the extant range of the species have been identified that have characteristics suitable for *J. reclinata* introductions and have land managers amenable to restoration efforts. Previous RAPD analysis by H. Thornton indicated that genetic diversity of natural populations was positively correlated with population size; the two largest populations had the highest genetic diversity and the smallest populations had relatively low genetic diversity. Despite habitat fragmentation and large distances between some populations, migration rates were very high between populations (m = 4.05). Within the past four years, we have introduced 935 *J. reclinata* into five locations. These have varying founding population size, patch size, and connectivity to extant populations. Survival of transplants has ranged from 8% - 98% depending upon experimental protocol. We are collecting demographic data that will ultimately build a metapopulation model involving wild and reintroduced populations and will serve as a model for other systems.

Keywords: endangered species, metapopulation, reintroductions

Is hydroseeding always needed in the revegetation of motorway slopes?

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Increasing rate of road construction is leading to a parallel increase of areas of poor soil and steep slopes that need revegetation. Hydroseeding with commercial seeds of fast-growing and competitive plant species is a widespread practice for the revegetation of motorway slopes. We have carried out a three-year monitoring of the evolution of 48 hydroseeded and non-hydroseeded motorway slopes in a mild and relatively humid Mediterranean zone in Málaga (southern Spain). Main objectives were to test whether hydroseeding significantly increases species richness and plant cover, and whether hydroseeded species facilitate the establishment of the vegetation and quickly disappear once the communities are established. The herbaceous communities found in the slopes were rich and with high cover (50-80 species per slope, 85-95% cover). Cover of hydroseeded species was very low throughout the study, indicating a relatively poor performance of hydroseeded species. Besides, either their presence or abundance did not significantly vary over time. Both hydroseeded and non-hydroseeded communities exhibited a significant decrease in species richness, a significant increase in plant cover and a highly dynamic species composition throughout the study. There were no significant differences in plant cover, species richness and aboveground biomass between hydroseeded and non-hydroseeded plots over time. Our results demonstrate that there are situations in which the use of hydroseeding for revegetation is not needed. However, more studies are required to facilitate the establishment of autochthonous species and to identify environmental conditions under which the addition of commercial seeds may not be needed.

Keywords*:* hydroseeding, motorway slopes, plant cover, restoration, species richness**.**

Ecological Restoration, a theoretical and practical vision of its application in Cuba

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Natural resources conservation, which comprises actions like protection and sustainable use, is the main way to keep big nucleus of ecologically valuable wild life for the future, However, there are fewer places to conserve each day; we just have to take a look around us to see how vast areas are used by man to build all kinds of structures, and how areas, that seem to be conserved at first sight, when analyzed in detail show the result of anthropic actions. What should we do so that these damaged ecosystems do not look like foreign landscapes, or to recover part of their typical features and functions? Should we reforest, rehabilitate, use another technique? Or should we restore?. Ecological restoration is the most effective way to achieve this recovery; however, in Cuba, reforestation have been the most common technique used for the recovery of damaged habitats because of the need to recover damaged wood territories in the shortest time. Therefore, in order to ensure success, exotics fast growing species were introduced. During the last few years, other conservation techniques for the management of damaged ecosystems have been introduced, among them, rehabilitation and environmental sanitation, which have been applied with good results in the recovery of mined areas, watersheds and sources of polluted waters. However, ecological restoration was not used in Cuba until 1998, when such kind of projects were consolidated in Villa Clara, a province located in the central part of the country. The development of these projects promoted the creation of the Cuban Group of Ecological Restoration, having as a main objective to encourage ecological restoration for the recovery of damaged ecosystems in the country. This paper analyzes the theoretical and methodological basis on which the Cuban Group of Ecological Restoration labor is supported and shows different activities carried out by the group to achieve its objectives. Besides, it brings to light the main results obtained through ecological restoration projects, as well as future prospects regarding the Group's work and the application of this technique in Cuba.

Aspects of historical resource management of a highly valued weaving plant in New Zealand

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Historical resource management of harakeke (*Phormium tenax*: Phormiaceae) by Māori, the indigenous people of New Zealand, was investigated. Harakeke is a weaving plant traditionally used to produce clothing, baskets, mats, fishing nets and other essential items, and it remains highly valued. I hypothesized that harakeke has historically been actively managed by Māori, with resulting modification of the New Zealand

landscape. Research methods included analysing historical documents, interviews with elders, and examination of herbarium specimens. Evidence from these sources supports my hypothesis. Māori identified around 60 specific harakeke varieties for their high quality fibre, and many of these were dispersed around the country. Many varieties were extensively cultivated using an array of management techniques, some of which are no longer evident because of loss of traditional ecological knowledge. Although there appear to be regional differences in practice, the evidence suggests that sough after varieties of harakeke were managed in relation to environmental factors, and using specialised propagation and harvesting methods. Historical projects such as this illuminate our understanding of past processes of modification to natural areas, and the relationship between communities and plants, particularly where these have high cultural values. Traditional Māori practices and knowledge can be incorporated into restoration management plans.

Keywords: harakeke, Phormium, Phormiaceae, indigenous, Māori.

Does Ecosystem Rehabilitation Promote Ecosystem Health? A Testa With Applies Disturbandes

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An implied assumption of ecosystem restoration is that the "health" of the ecosystem is improved by its restoration. We studied how applied disturbances could assess ecosystem health, in terms of resilience and stability, of a deteriorating salt marsh in the southern United Sates that was rehabilitated with different amounts of sediment-slurry enrichment. For the vegetation, we found that resilience and stability were strongly and positively affected by elevation, which matched a priori estimates of health. Lethal disturbande (herbicide application) in the lowest elevation sites (+0 cm) lead to no vegetation recovery, indicating a lack of statility, and the marsh switched to a new steady stata (a mudflat). In stark contrast, the highest elevation plots recovered completely from lethal disturbance and somewhat more quickly than the mid-elevation plots (11% versus 8% recovery mo-1, respectively). Non-lethal disturbande (trimming at the soil surface) also showed that recovery to control values was directly associated with elevation, but this not indicate any lack of stability. For soils, we found that disturbance head no effect, and thus soils at this site appeared to be resistant to disturbance, possibly because other factors (e.g., water level fluctuations, sediment addition) were more powerful in affecting soil chemistry than vegetation and its removal. We conclude that underlying stressors in the system and accurate assessments of the resulting system health, and that this method could be used in other marshes or herbaceous ecosystems to probe ecosystem health.

Keywords: disturbance, resilience, stability, ecosystem, health, wetland.

Point fraser development: Environment and the city

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Earmarked as an iconic project utilising best practice environmental and urban design principles, the Point Fraser Development is an important spatial link within the city; connecting it to the water's edge, providing dynamic spatial experiences [public, private, active and passive] and offering opportunities for human interaction with the natural environment. This multi-objective project involves receival and treatment of urban stormwater, habitat creation, educational and interpretative opportunities. The success of the project is connected to the sound integration of science, engineering, landscape and architectural disciplines, which culminated in a contemporary landscape design built on a sound understanding of the local and regional environment.

Keywords: landscape, masterplanning, recreation, ecological restoration, end-use options.

Designing landscapes to achieve completion criteria on the Scott River Plain, Western Australia

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The rehabilitation of the BHP Beenup site South- WA provided unique challenges due to the requirement for re-establishment of rare and endemic vegetation communities each with particular soil, hydrological and topographical requirements. The landscape design was critical to the restoration of thirteen vegeta-

tion communities and to the reintegration of the site with the surrounding natural ecosystems. Syrinx Environmental PL designed the restoration of this site and this paper will describe the process with particular reference to: the use of site specific investigations in the design of revegetation planning; techniques for the restoration of complex communities; matching restoration design to landscape constraints, and; the use of baseline density data of adjacent natural vegetation, soils and hydrology to generate restoration protocols and develop final completion criteria.

Keywords: Restoration, completion criteria, vegetation monitoring

Case Study of Point Fraser Demonstration Stormwater Treatment Wetland, Perth, Western Australia (for inclusion in the ecological restoration in urban zones stream)

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By committing to best practice river and stormwater management and policy development, the City of Perth has established a benchmark through the Point Fraser project in protecting the Swan River, restoring habitat, attracting wider community ownership and promoting human use and appreciation. The site is located close to the central business district and features interpretation, landscape design, innovative bioengineering technologies and the re-introduction of endemic plant communities and species previously alienated from the area by development. This paper provides an overview of the design and implementation of the Point Fraser Demonstration Wetland from masterplanning to staged construction works and evaluation, and focuses on the idea of scientific process in the design and restoration of constructed landscapes.

Keywords: Stormwater treatment, best management practice, wildlife habitat, recreation, aesthetics.

Proposal for the environmental assessment of degraded areas associated with old hydropower facilities in the aragonese pyrenees

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Many rivers in the Spanish Pyrenees have a history of regulation for hydropower. Currently, a number of hydropower facilities are obsolete. The restoration of degraded areas associated with such obsolete facilities must include an analysis of all components of the environment and an assessment of the conservation status of this environment. In addition, it is necessary for this type of work to establish priorities and levels of intervention that can be applied in the restoration process. This paper illustrates a simple but efficient process for quantifying the environmental value and conservation status of 10 areas occupied by obsolete hydropower facilities in the Aragonese Pyrenees, Spain. The areas are all associated with natural Ibones systems. In each case, hydropower regulation has left a legacy of dams, buildings, cable cars, gravel processing facilities and associated infrastructure. The restoration of a particular Ibone system considers the specific characteristics of that location, including species and habitats of special interest and the nature of the hydropower facility that has been responsible for the degradation. These characteristics represent the basis upon which an appropriately prioritised restoration plan can be developed. The paper describes work that is ongoing.

Keywords: rivers, conservation status, restoration.

Spatial ecology of natural shrublands versus vegetation restored following sand mining in SW Australia

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It is now generally accepted that most species in natural ecosystems show strongly aggregated patterns of distribution at the local scale. This aggregation may be a result of several natural processes, but ultimately may mediate competitive interactions among species. Despite this, there has been little considera-

tion of the spatial ecology of reconstructed ecosystems where revegetation processes (e.g. topsoil stockpiling and redistribution, broadacre seeding, nursery stock planting) might lead to different species patterns (random to regular), which consequently may effect competitive interactions and ecosystem recovery. We tested this hypothesis by analysing spatial pattern for plant species in two restored shrubland sites on heavy mineral sands at Eneabba, Western Australia, and compared these patterns with those for four adjacent, undisturbed sites. We further hypothesized that the reintroduction of fire (a key natural process) to the restored sites would drive the system towards greater species aggregation, and so, greater similarity to natural analogues. Preliminary results show strong differences in levels of species aggregation between reconstructed and natural shrubland sites and suggest a role for fire in driving spatial pattern in these reconstructed ecosystems.

Keywords: spatial pattern, aggregation, fire, shrublands, reconstructed ecosystem.

A methodology for assessing the potential for riparian forest restoration using remote sensing, GIS and multivariate florisitic analyses at multiple spatial scales

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Timber management has reduced the diversity of forest seral age classes at the Cedar River Watershed in the Pacific Northwest, USA. The harvest of conifer in riparian areas has resulted in a disproportionate share of red alder (*Alnus rubra*) and shrub dominated stands. This loss of late seral conifer is associated with a decline in salmon habitat. Under what conditions should we restore conifer to invasive deciduous communities to promote fish habitat? This research provides an analytical framework for addressing this question at multiple spatial scales by incorporating three interdisciplinary tools: remote sensing, GIS, and multivariate statistics. Remote sensing is used to characterize the current range of riparian conditions at the watershed scale and create a streamside forest layer. This is a cost effective means of mapping the distribution of riparian habitat types at an accuracy of > 80% when compared with field observations. Using this map layer, a habitat suitability model is developed with GIS to identify a suite of suitable conifer restoration sites based on the geomorphic context and streamside vegetation. Once these potential sites were identified, a multivariate statistical approach is used to examine the spatial distribution of riparian species assemblages as they vary across alluvial landforms. The floristic analysis identifies plant communities and micro-scale landforms that have the greatest probability of sustaining conifer restoration long term given the fluvial disturbance regime. This collective research can be used as a methodology for addressing the question of riparian forest restoration over large spatial scales.

Keywords: Riparian forest ecology, site selection, riparian restoration, hardwood conversion, plant community, alluvial landform, remote sensing, GIS, habitat suitability model, multivariate statistics.

The study of quantitative and qualitative characterastics of *Avicennia marina* trees seeds for seedling production in protected zone Malgonzeh, Iran

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This research has been done in order to consider particulars quantitative and qualitative characterastics of *Avicennia marina* seeds for seedling production. Propagules of *Avicennia marina* collected in early september of mother trees. Propagules classified by diameter to three qualitative classes: class 1(d>20 mm), class 2 (d : 15-20 mm), class 3 (d<15 mm).For determining percentage of germination, 90,180.180 seeds from class 1, 2 and 3 in order to were grown the same canditions and then studied them after 25 days. Also evaluate the seedlings of different classes ; in nursery 25, 60 and 60 seeds from class 1, 2 and 3 in order to were grown in plastic pots (18*25 cm) contamining sand. The pots were covered by gunny covers.The irrigation system was dropping .After 4 monthes, the seedling height, bole diameter and number of leaves in every seedling, werw measured. The results show that the percentage of germination and the quality of produced seedlings of first class seeds were better than other classes therefore, its recommended to use the first class seeds for producing best seedlings, we use second class seeds when we need more seedlings.

Key words : *Avicennia marina*, seed, percentage of germination, seedling.

Ecological restoration and stabilization of slopes: speeding up system self-organization and functional enhancement

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Ecological restoration promotes the design of sustainable and effective ecological systems for stabilization of natural and man-made slopes by combining living and non-living materials. Self-organization must be part of the design, but the performance of these systems need to be field-tested beyond describing a successful ground cover or native vegetation establishment. The aim of this paper is to demonstrate experimentally the advantages of ecological engineering for creation of self-assemblying systems using a steep, fine-textured and bare fillslope. The study site was located in Galicia (NW Spain), within an area where annual precipitation exceeds 2,000 mm. A new biodegradable erosion control mat (ECM), live-staking and native grass hydroseeding were used as engineering techniques for slope restoration. The experimental design consisted of three replicated treatments, i.e. combinations of the previous techniques. The ECM was made of interlocked fibers of native shrubs, and presents a relatively high water holding capacity. ECM and vegetation biomass may provide soil reinforcement and protection and also control water cycle by the aboveground structures and by the root system. Most plant species form symbiosis with arbuscular mycorrhizal (AM) fungi that improve plant growth by taking up mineral nutrients from the soil and enhance soil structure by stimulating the formation of water stable soil aggregates. A successful establishment of AM fungi is probably critical for a successful whole system creation on man-made bare slopes, either by seeding or by spontaneous vegetation establishment. We investigated experimentally the influence of engineering after five and 13-14 months. Establishment of willow from stakes was successful and compatible with other vegetation development; its aboveground canopy cover and height suggested a complementary stabilizing root anchoring. Treatments with ECM showed almost two times less water runoff rate and three times less soil erosion rate after intense rainfalls. ECM also promoted the increase of the amount of soil AM fungi; the establishment of shrubs and perennial grasses; the development of a more complex aboveground system structure; and the long-term stabilization of water and soil matter outputs of the system. It can be concluded that using engineering techniques on a fillslope for restoration purpose can improve the self-organizing ability of living components of an ecological system and its functional enhancement.

Keywords: ecological engineering, mycorrhiza, runoff, slope, soil erosion.

Creating wetlands for the restoration of salinized soils and degraded habitats in semi-arid environments

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Agricultural activities in the semi-arid Monegros region, Ebro River Valley, NE. Spain, impacted negatively the soils and habitats of extensively irrigated soils. Ecosystems lost most of their original features leading to a decline of landscape diversity and an increase of water pollution from fertilizers. In addition, large areas were submitted to a process of salinization preventing their agricultural use. Created wetlands have been established in one of these impacted zones. The goals of the experimental program are: removing nutrients from contaminated wastewater from irrigated fields, decrease soil salinization, and increasing habitat diversity and connectivity. The comparison of this created system with naturally established habitats of this type will allow defining the efficiency of the restoration activity.

Keywords: Soil, saline, habitat, wetlands, water quality, diversity.

Defining Riparian Restoration Goals in a Pueblo Indian Community

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Much of the floodplain forest and wetland along the middle Rio Grande in New Mexico, USA has been occupied by Indian tribes for centuries. Their participation is now crucial in restoring the river after severe alteration by channelization, cessation of flooding, geomorphological disruption, lowered water tables, invasion by non-native trees, and wildfires. Floodplain forest/wetland restoration at San Juan Pueblo, one such tribal community, began in 1999 with limited funding and poorly defined reference conditions. As the project ex-

panded to plan for restoring over 700 hectares of floodplain ecosystem along 16 kilometers of river, it became urgent to articulate both cultural and ecological restoration goals beyond "returning to natural conditions". This paper explains how restoration ecologists and Pueblo residents collaborated to integrate eco-historical research with Pueblo cultural values to define restoration goals. There are no undisturbed reference sites and no quantitative historical sampling data, so other approaches were used: information from historical research, geomorphological analysis, air photos, and literature review was combined with interviews of elders, Pueblo landscape memories and desires, and sampling previously unrecognized micro-sites found by Pueblo residents. Results of this work are discussed, along with a composite vision of reference conditions, and rationale for selection of a reference time period, applicable to an ecosystem that has included human residents for centuries. Goals now include detailed plans for restoring the degraded river channel itself, and the process is transferable to neighboring communities managing over 50 kilometers of the Rio Grande.

Keywords: riparian restoration, restoration goals, reference conditions, Pueblo Indians, indigenous communities.

Can we predict the development of plant communities on restored saltmarsh?

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Saltmarsh restoration and creation projects are increasingly included in flood defence schemes and as mitigation for coastal developments. In the UK, about 140 ha must be created each year to compensate for current and historical losses. The EU Habitats Directives requires created habitat to be within "equivalent biological limits". Seventeen schemes totalling 500 ha have been created to date, with 50% of this area flooded within the last three years. Despite the widespread and large-scale implementation of such projects, we know little about the long term development of plant or animal communities on these sites. Some of the UK sites have been monitored, but few of these results have been published in the peer-reviewed literature. Large scale studies in the USA have found that created or restored marshes often remain different to natural sites, even after decadal timescales. We surveyed fifteen natural and ten restored marshes, including both managed retreats and older sites created during the past century by accidental storm-surge breaching of seawalls. There are clear differences between the vegetation communities found on managed retreats and natural marshes. Managed retreats are characterised by the dominance of low marsh vegetation. Older marshes still show significant differences to nearby natural marshes. Regenerated vegetation on marshes of all ages is more homogeneous than natural marshes. The possible reasons for these differences, including elevation, drainage and soil properties will be discussed.

Keywords: marshes, restoration, vegetation communities.

Long-term development of restored calcareous grassland

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Much lowland calcareous habitat, identified as of interest in Annex 1 of the EC Habitats Directive, has already disappeared in the UK. It is an important habitat for many declining plant, invertebrate and bird species. Restoration of calcareous grasslands is used to reverse these declines, but little is known about how well populations of key species develop and persist over time in restored habitats. A controversial motorway construction in southern England, at the start of the 1990s, allowed a comprehensive, long-term investigation of downland restoration. Preliminary studies collated existing information and surveyed existing communities before restoration. The site had been under arable cultivation, so nutrients were stripped by soil removal. Translocation of grassland turf from the route of the motorway covered less than 4% of the restoration area, so most of the area was restored using seed mixes. An exceptional pledge to follow-up by the Highways Agency funded detailed monitoring for ten years. Data collection identified all plants and measured cover values for each species in fixed quadrats. Our data illustrates the dynamics of colonisation and species turnover. Additional systematic presence/absence records have demonstrated the pivotal role of the innovative methods used for the layout of the translocated turf. An original checkerboard design maximised the restoration area that benefited from this limited resource. A novel quantitative method was derived to assess the development of plant communities compared to typical southern chalk downland vegetation. Systematic invertebrate sampling has shown species associated with downland habitat colonising as the vegetation has established.

Keywords: calcareous grassland, translocation, monitoring, colonisation.

Approaches to the restoration of floodplain forests in Europe: a way of providing guidance for policy makers and river managers

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One objective of the European project FLOBAR 2 (FLOodplain Biodiversity And Restoration: integrated natural science and socio-economic approaches to catchment flow management) was to produce a document for policy makers and river managers in Europe. The document's aim was to promote the restoration of floodplain forests by providing, in an accessible way, information on the key biological and physical processes that underpin functional floodplain forests and the institutional and policy contexts within which their restoration could proceed. The 90-page-document was published in 2004 and gives, in five sections, answers to simple questions such as: How do floodplain forests work? What are the key hydrological, geomorphological and biological processes? How can floodplain forests be restored? It recommends managing hydrological processes at a catchment scale with a long-term vision and returning a great variety of inter- and intra-annual flows to rivers. The idea of giving rivers more space is also advocated. Numerous examples are used to demonstrate a variety of approaches to floodplain forest restoration. The document can be downloaded on www-flobar.geog.cam.ac.uk. and has had excellent take-up in some European countries and in north America.

Keywords: guidance, restoration, floodplain forest, policy makers, managers.

Abandoned Agricultural Land in Sonora, Mexico

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This case study details the difficulties of landscape management; highlighting the challenges inherent in managing natural resources when multiple agencies are involved, when the land users have no incentive for conservation, and when government agencies have too few resources for effective management. Pumping of ground water from the aquifer of La Costa de Hermosillo in the state of Sonora, Mexico began in 1945 and developed so quickly that by the 1950s salinity intrusion from the Gulf of California was occurring in the wells. In the 1970s, the irrigatable land in La Costa peaked at 132,516 hectares and the extracted volume of water from the aquifer peaked at around 1.14 billion cubic meters annually. By the 1980s, 105 wells out the total of 498 were contaminated with seawater and identified for closure. At present La Costa de Hermosillo still represents 15% of the total harvested land, 16% of the total annual production, and 23% of the gross agricultural production of the state of Sonora. However, there are approximately 80,000 ha of abandoned fields due to salt-water intrusion, lack of water, and/or lack of credit available to individual farmers. This unstable situation resulted from the interplay of water management policies and practices, and farm-land policies and practices. While government agencies have been able to enforce better water use for agricultural production, there remains a significant area that requires revitalization to a productive state. For this piece of the ecosystem management puzzle, government agencies have thus far been unable to affect a solution.

Keywords: Sustainable Agricultural, Salinization, Irrigation, Ground Water, Water Management, Restoration, Sonora, Mexico.

Plant Community Development in Disturbed Ecosystems: Factors Affecting Community Direction

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Restoration research has been conducted on diverse anthropogenically disturbed sites in a variety of ecosystems in western Canada. Sites include mines in subarctic tundra and boreal forest, pipelines through mixed grass and fescue prairie, and waste sites / landfills in national parks representing aspen

parkland, montane and fescue prairie habitat. This research has identified common factors that impact plant community development. The effect can be negative or positive depending on the type of disturbance, ecosystem and stage of community development. The key factors include precipitation, species richness and composition of adjacent plant communities, land use on-site and adjacent, soil physical and chemical properties which affect plant growth, in particular organic matter, nutrient and moisture content, and the presence or absence of a relict soil propagule bank and its composition. Data will be presented to demonstrate the magnitude and direction of impact each factor can have on plant community development in western Canada. Other factors, which are just beginning to be investigated, will be briefly discussed, including more intricate soil-plant relationships involving soil microbial and fungal communities and their effect on seed germination and plant establishment. An understanding of the science behind these factors clarifies the array of possible restoration pathways and outcomes and allows for effective and realistic goal setting and management in restoration projects.

Keywords: plant community development, soil-plant relationships, alternative states, anthropogenic disturbances.

Restoration and Management of the Wetlands of Kerala

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Important of wetlands as natural water purifiers and life-supporting system is significant today, especially in the developing world where demands of increasing population together with pollution, encroachment and inefficient management pose serious threat to the wetlands environment. The State of Kerala with heavy rainfall and one third of the designated wetlands of India faces seasonal water shortage, as a result of the destruction of wetlands. The wetlands act as natural recharging mechanism of groundwater for most parts of the State. All rivers in Kerala are highly polluted and they carry tremendous pollution load into the wetlands. Projects to multiply rice production in the wetlands area resulted in the deterioration of surface and groundwater in central Kerala, making water unusable in the once freshwater rich region. The large number of ponds, wells and canals in the wetlands region on which majority of population depended for all domestic uses till few decades back are now highly contaminated. Water in the only freshwater wetland in central Kerala is no more potable. Wetlands restoration is vital for the millions who depend on their resources for livelihood. The present study is an assessment of the human interference on the three wetlands of Kerala and its impact on the society. With the current rate of human impact, weak government policy and drawbacks in policy implementation, loss of wetlands will be irreparable in near future. Considering the present situation and future trends, some suggestions for the restoration and efficient management of the wetlands have been presented.

Keywords: Wetlands, Kerala, destruction, restoration, management.

Monitoring forest restored areas in Southern Spain

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Assessing the response of ecosystems to restoration relies on comparisons of ecosystem attributes between restored and reference areas. Although this approach provides an objective basis for judging project success, inferences can be constrained for the high variability of attributes between restored and reference sites. Furthermore, such assessments have been usually conducted for restoration projects but there is a lack of monitoring studies in forest restored areas. It is important, therefore, to conduct monitoring studies of reforestation activities conducted many decades ago. As part of REACTION project a monitoring program of pine forests restoration projects in Andalusia (Southern Spain) has been established. The following four elements of monitoring have been considered: (1) pre-restoration monitoring, (2) standard monitoring protocols, (3) functional assessment, (4) long-term monitoring. A monitoring framework of previous forestation projects can help to ensure the main components necessary for an effective restoration of Mediterranean areas. Pre-restoration monitoring is important to establish baseline conditions and to identify sensible areas. Standard monitoring protocols help to ensure that consistent monitoring methods will be used. Functional assessments could be applied to determine whether restoration projects are providing the intended function. As a result, adaptive management of reforested areas provides a framework for addressing uncertainty, improving decision-making, and continually evaluating of current restoration project success. Devoting sufficient project resources to the design and implementation of these important restoration components will help ensure that project goals and objectives of forests restoration projects will be met in the future.

Keywords: forest restoration, monitoring protocols, long-term

Evaluation of the restoration of a grassy woodland in Australia

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By planting trees and shrubs, restoration practitioners aim to initiate a succession of vegetation change, involving re-colonisation of native species, reduction of weed species, and increasing compositional and structural resemblance to remnant woodland. To assess these processes, I carried out a comparative analysis of remnant woodland (reference), revegetated agricultural land (treatment) and pasture (control) using space for time substitution sampling. Results indicated that the species composition of the three vegetation communities remained distinct after 11 years. Although species composition of treatment sites changed, there was no evidence of convergence*t* towards reference conditions. Native species richness was lowest in pasture, and was significantly higher at restored sites, which were not different to remnants. An experiment to compare germination and establishment of native seedlings between remnant woodland, revegetated agricultural land and pasture after autumn fire and slash/herbicide treatments was also undertaken. Germination of native species was found to be low in restored vegetation. The autumn slash treatment was found to encourage germination of annual exotic species. When the autumn slash treatment was combined with the fire treatment, germination of annual exotic species was reduced in conjunction with an increase in the germination of perennial native species. Combinations of autumn burning and slashing may therefore result in increased in native species richness in restored vegetation and provide land managers with a viable broad scale option to accelerate restoration. Although some restoration processes may be underway, convergence of restored agricultural land with remnant woodland may take many years to achieve.

Keywords: evaluation, restoration, revegetation, agricultural land, succession.

Designing slopes topography for erosion and water deficit control by applying RUSLE, in a surface coal mining reclamation project (Utrillas coalfield, Spain).

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Erosion is an abiotic exploitation mechanism that delays ecological succession and limits the success of revegetation. One of its main effects on the slopes of reclaimed opencast mining areas subject to Mediterranean-continental conditions is the intensification of the water deficit owed to reduced soil infiltration and water storage capacities. Improving of water availability for plants and soil erosion control must be based on an adequate topographic design. Using an experimental design involving 9 plots and artificial rainfall experiments, the hydrological response of the vegetation on two types of soil was investigated. On 20º slopes with a X*erochrept*-type topsoil which had been worked transversally with 7-10 cm furrows, the vegetation grew well (37-86% plant cover, biomass 380-516 g m^{-2}) and the soil showed good hydrological behaviour (infiltration of 94% of yearly rainfall, final infiltration rate 10-25 mm h^{-1} and annual erosion rate 50-300 g m^{-2}). On overburden soils, however, the development of vegetation was scarce (1-13% plant cover, biomass 5-169 g m^{-2}) and the soil erosion very intense (1100-7300 g m^{-2}). A three-step protocol using RUSLE 1.06 was applied in order to design macro and micro-topography: 1) adaptation of the model to local conditions (though the method overestimates sheet erosion and underestimates rill erosion, the adjustment was satisfactory); 2) establishment of the maximum erosion rate that guarantees plant growth viability (10t/ha/year for topsoil and 3 t/ha/year for overburden); and 3) use of RUSLE 1.06 to determine the topography (LS) and microtopography (ridge height) compatible with the development of vegetation on each type of soil. It is concluded that this approximation has been of clear practical use.

Keywords: RUSLE, Reclamation, Opencast mining, Soil erosion, Water deficit.

Relation between channel cross-section shape and sediment transport

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Much research has been conducted to predict sediment transport, and many empirical and semi-empirical equations have been developed, none gives us a complete detail about the effect of cross section geometry on sediment transport. The effect of many variables on sediment transport has been understood; however, the influence of other variables still required additional research. The objective of this research is to study the effect of the cross section shape on the sediment transport. The uncertainties as-

sociated with the variation of the physical characteristic of natural rivers, limited sample data, and inherent measurement errors will cause uncertainty in the parameters that describe the channel. To deal with those uncertainties that relate to the cross section the statistical characterization of channel cross-section geometry were used in this study. One way to describe irregular cross section geometry is by modeling flow depth as power function of the channel geometry proprieties (top width, flow area and hydraulic radius). Another way to deal with irregular cross section is by modeling the cross section as a function of effective width and effective width then width/depth ratio was found. In this study, the effect of cross section geometry on sediment transport was demonstrated theoretically by inserting the shape factor in sediment continuity equation and analytically by utilizing the field data sets (natural channel) for Yalobusha River, Mississippi. Geometry of the river is represented by cross sections that are specified by coordinate points (stations and elevations) and the distances between cross sections. Twenty cross sections for Yalobusha River were used in the HEC-RAS model, flow data and boundary conditions were also entered to perform the calculations. When the hydraulic parameters for every cross section are obtained, the sediment transport was computed by using selected sediment transport equations. The possible relationship between shape factor and sediment transport can then be assessed. The shape factor is inserted in the sediment continuity equation the result show that the shape factor and scale factor for successive cross sections can be used to predict the sediment concentration. This can be achieved by knowing the sediment concentration at the first cross section in addition to other hydraulic parameters that appear in derived equation. There is strong relationship between sediment transport and the ratio between effective width to effective depth. It was found as a width depth ratio increases the sediment transport decreases.

Keywords: sediment transport, channel, cross section geometry, shape factor, width depth ratio.

Improving restoration management of coastal dunes: Scarabid beetles show the way

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Active dune stabilisation by planting of trees and marram grass, atmospheric nitrogen and sulphur loads, and desiccation changed a main part of European coastal dune landscapes from dynamic systems with sand-spray to a grass-encroached stabilized system. Lack of freshly deposited sand limits vital growth of roots and shoots of marram grass. These changes affect the above and below-ground fauna. The Scarabid beetle *Anomala dubia* is abundant in pristine fore-dunes. Their larvae feed on roots of marram grass. To study whether the development and density of *A. dubia* larvae are affected by sand-spray and root biomass, a comparative field study was performed in pristine Danish dunes and degraded and reactivated Dutch dunes. Densities of *A. dubia* larvae were highest if sand is deposited, marram grass is vital and forms fresh root biomass. In part of the Dutch dunes where restoration measures resulted in renewed sand-spray, larval densities were comparable to densities in pristine dunes. In several reactivated dunes the density of larvae was comparable to those in pristine dunes. Other herbivores on roots and shoots are probably affected by plant biomass production and quality in a similar way as *A. dubia*. Thus, reactivation of sand-spray is a promising restoration measure in coastal dunes.

Keywords: invertebrates, coastal dunes, lifecycle, root biomass, sand-spray

Testing management procedures in a revegetaded Mediterranean limestone quarry

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This work aimed at evaluating the effect of *Pinus halepensis* thinning on the development of vegetation in limestone quarry platforms which were revegetated more than ten years ago. Aleppo pine is frequently used as a pioneer species for restoration of highly degraded areas. Despite its important role in the first years, its success may hinder plant community development. This may be particularly unsuitable for degraded areas within natural reserves, if the restoration goal is to attain a plant community structure and composition similar to the surrounding ones. It may therefore be necessary to implement management procedures some years after revegetation, in order to redirect the restoration course. In this study, we tested two levels of pine thinning (10% and 40%) in two quarry platforms of different ages since revegetation (19 and 13 years). Plant characteristics such as density, diversity, seedling establishment and shrub growth were evaluated in 12 plots (4.5m^2 each) per treatment. Data from the first two years after thinning indicate that species richness was favoured by thinning, with more herb species being found. Plant

density increment was only relevant for herbs, particularly in the older platform. Seedling density of spontaneous woody species increased with pine thinning at the younger platform. Woody species growth was not significantly affected by treatment. The results suggest that, on the short-term, there are some positive effects of pine thinning on the studied plant community. Continued monotorization will allow to determine whether these effects are permanent or not, and if further consequences of pine thinning will emerge, e.g. in the development of the other woody species.

Keywords: limestone quarry, Mediterranean vegetation, pine thinning, management

Landscape restoration after elimination of eucalypt plantations in Monfragüe Natural Park (southwestern Spain)

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An 852 ha area of Monfragüe Natural Park suffered in 2001 an afforestation to recover the native Mediterranean shrubland with emerging oak trees. Two soil treatments based on the ground alteration were used: *moderate* (pre-existing terraces were conserved) and *intense* (terraces were eliminated). Two main research objectives were addressed: long term monitoring of the soil properties and performance of shrubs and oak seedlings. We used two levels of approach: (1) Intensive study of shrub-oak seedling interactions, in which three cohorts of 1000 seedlings were monitored under four experimental treatments (*control*, *shade*, *shrub cut down* and *ploughed*). We analyzed growth and survival of seedlings as well as aboveground and belowground microclimatic conditions for three years. (2) Extensive study of soil properties and vegetation (shrubs and oak seedlings) recover: we monitored soil properties, growth and survival of 200 seedlings in 20 permanent plots in each soil treatment. In the intensive level significant differences were observed in seedling survival, growth, and water soil availability, seedling survival being higher in ploughed and lower under shrubs, denoting the existence of a competitive effect. No effect of year, cohort and source plant was detected. At the extensive level we detected differences between treatments, seedlings survival being higher in the intense one (59.7% vs 37.4%). In addition, our data showed higher natural shrub cover in the moderate treatment (41.17% vs 26.17 %), and improved soil parameters under shrubs. These results suggest that in oak-shrubs interactions competition for soil water outweighted facilitation via shade in the semi-arid environment.

Keywords: afforestation, shrub-oak interaction, seedling survival, soil resources.

Planning sustainable cities in Africa

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The Millennium Development Goals underline the need to urgently improve the lives of millions of slum dwellers around the world, and to reduce the number of people without sustainable access to drinking water and sanitation. As cities grow and slums expand in Africa, the quest for urban sustainability ought to give priority to the 'brown agenda' that addresses the health and development concerns of the poor. This way, we can build cities that are inclusive, socially equitable and environmentally sound. This paper considers how best to support and regulate the urban informal sector and irregular settlements in Nigeria in a way that promotes employment, income and shelter for the poor, and at the same time ensures a safe, healthy and socially acceptable environment; how informal settlements and enterprises can be upgraded and progressively integrated into the urban mainstream. It examines the essential elements of a strategy to improve urban public health and the conditions of the poor, paying particular attention to the roles which state and local authorities, the international development community, and the urban poor themselves could play in a collaborative effort to build safe, healthy, just and inclusive cities. In this regard the paper draws insights from the global action agendas of the last decade or so, which embody the principles of urban health and sustainability. These include the Local Agenda 21 of the Rio Earth Summit, the Habitat Agenda of the Istanbul City Summit, WHO's Healthy Cities Programme, the World Bank's Cities Alliance for Cities Without Slums, UN-Habitat's Campaigns for Urban Governance and Secure Tenure, all of which provide helpful ideas on how to improve urban public health, and ensure adequate shelter for all.

Keywords: Africa, sustainable development, urban sustainability.

Wetlands restoration – a river basin perspective

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Restoration of wetlands in the river basin except "in-situ" environmental engineering measures means also bringing hydrological regime of surface and/or groundwater suitable for wetland ecosystem development. From this perspective, wetlands become one of many water users of the hydrological system. The river basin management plans are derived in top – bottom approach; water balances are performed on the basin scale (10^3 to 10^4 km2 in area) where water needs of particular water users are analyzed and compared with others. In general, there are two main tools used for establishing the water management plans on the catchment scale, namely surface water balance models and/or regional groundwater models. Running these models and comparing different alternatives derives water policy. Each alternative contains a combination of the system parameters (e.g. volume of the projected reservoirs), decision rules parameters (e.g. for irrigation scheme operation) and hierarchy of the water users. Water management alternative is chosen with help of different decisions criteria, describing the consequences of water deficit. In order to perform necessary calculations for the catchments where wetlands are present or restoration measures are planned, water demand of different type of wetlands, and their water supply system as well as decision criteria has to be established. In the proposed approach hydrological characteristics of particular ecosystems should be employed for this purpose. Their type of hydrological feeding describes, in general, the sources of water, yearly average water hydrograph describes the water demands and specific hydrological parameters for different habitats (e.g. flooding frequency, maximum depth of groundwater, average waterlogging period, etc.) might be used as decision criteria.

Keywords: wetlands, river basin management plans, modeling.

Management Support System for Biebrza National Park – experience with implementation

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The presented project has envisaged a supporting tool for governmental and non-profit nature organizations in the Biebrza region in their efforts for sustainable management of the Biebrza National Park. It was done in the frame of the PIN-MATRA project by several Polish and Dutch institutions including universities, research institutions, park administration and NGO's. Management Support System (MSS) was aiming at several functions: streamlining and formalizations of various knowledge sources; identifying gaps in knowledge; focusing monitoring programmes and adding to transparency in decision making. MSS consist of three parts, namely: data catalogue and GIS, hydrological module and ecological module. Implementation of the MSS in the Park showed a few limitations in the use of such tool including: gaps of knowledge in formalization of the ecological processes, institutional constrains on sharing data between administration and NGO's, individual approach of parks staff in using numerical based information. On the other hand MSS implementation was important step in the capacity building of the park administration, in structuring existing ecological and management data sets as well as introducing new approach in the decision making.

Keywords: wetlands, management, Decision Support System.

Restoration of the terrestrial habitat of Selvagem Grande

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The Selvagens Islands (30º 01´ 35" N and 30º 09' 10" N and 15º 52' 15" W and 16º 03' 15" W) represent an example that is representative of the ecological and biological processes occurring during the development of land and marine ecosystems and communities. Due to a rare combination of factors – namely location, isolation and difficult colonization conditions – they contain habitats that are representative and important for the conservation of species that are unique and/or vulnerable worldwide. In the past Selvagem Grande was subject to some introductions (namely goats, rabbits, mice and a one invasive plant) which were a source of habitat loss and deterioration, putting its natural heritage at risk. This was the

reason why the project "Restoration of the terrestrial habitat of Selvagem Grande" was carried out between 2001 and 2005. The project was based on three eradication programs: eradication of the tobacco plant Nicotiana glauca; eradication of rabbits Oryctolagus cuniculus; and eradication of mice Mus musculus (goats have naturally became extinct in the beginning of last century). This paper will deal with the successful eradication of the vertebrates species mentioned above, namely: (i) the techniques used; (ii) the mitigation actions to prevent the loss of non – target species, namely of important endemic bird and reptile species; and (iii) the monitoring techniques. One of the most important aspects of this project is the successful eradication of mice; Selvagem Grande is one of the largest islands in the world where this was achieved. Recommendations for similar projects to be carried out elsewhere in the world will be presented.

Keywords: Island ecosystems, endemism, vertebrate introduction, mice eradication.

Geomorphologic criteria to characterise the good ecological state of rivers. Application to restoration and preservation according to the European Water Framework

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The main objective of the EU Water Framework Directive (2000/60/CE) is to reach an optimal ecological "status" for European rivers. Therefore, it is necessary to establish the present state of each river reach on the base of physicochemical, biological and morphodynamical indicators. The system needs to be build up on a previous rivers typification which needs to be supported on geomorphological criteria. Our aim is to establish geomophological classification criteria and which are the indicators from a morphodynamic point of view. Several case studies of the Iberian Peninsula are studied in the search of determinant variables and parameters. River functionality is the main factor to determine conditions and thresholds between simple conservation or restoration, as well as to show up needed actions in order to guaranty a good ecological result. Semi-independent external variables as discharge, load and slope will be conditioning the stable morphology and pattern of a river reach as well as stream power, shear stress and velocity affecting stream stability or degradation. The ordinary channel needs to be considered also in relation to the floodplain, its extraordinary channel, as another necessary unit for shifting and self-adjusting capability of the river.

Keywords: European Water Framework Directive, fluvial morphology, geomorphic efficiency, floodplain activity.

Integrating ecological and social elements for riparian restoration activities. Experiences from western Mexico

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The riparian vegetation of the Ayuquila watershed in west Mexico is highly degraded especially in the agricultural floodplains valleys. In some cases these riparian buffers have been eliminated entirely, due to farming, industrial and urban activities which have indicated the need for restoration activities. In this context, our project was driven by the following goals: (1) Ecological characterization of riparian areas, to determine the status of vegetation and to identify priority riparian restoration sites for reforestation efforts. (2) Antropogenic use and management of riparian areas. (3) Support the development of a participatory riparian restoration program within the watershed. Until now, we identified 118 species of woody plants in 37 riparian buffer sites (600 m^2 each) along 90-km of the river. The total count ranged from 1 to 24 woody plants species per site. *Salix humboldtiana*, *Astianthus viminalis*, *Acacia farnesiana* and *Pithecellobium dulce* were the most abundant and frequent species. Three important aspects that influence the use and management of riparian areas are: width of the riverbed and riverbank, slope and the mode of agricultural production. Since 2003, small reforestation efforts within the El Grullo- Autlan floodplain in the Ayuquila watershed has been implemented and can be considered as first experiences for developing a participatory restoration program.

Keywords: riparian vegetation, socio-ecological components, participatory restoration.

Impact of the rocky bottom structural complexity due to hard harvesting of date shell (*Lithophaga lithophaga* L.) and disturbance of their population structure

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European date mussels (*Lithophaga lithophaga* L.) are endolithic, active boring bivalves, living in calcareous limestone alongside the Mediterranean and east Atlantic shallow coasts. Due to their overestimated flavor and price, date shells are illegally but constantly harvested, leading to the permanent demolition of the macro and micro structures of the limestone substrate. The resulting, immediate physical destruction of the associated epi-, endo- and mesolithion species radically degrades the originally wealthy rocky bottom communities, but in middle and long-term scale destabilizes their stable and luxuriant biodiversity. A survey of 41 stations/profiles along the West Istrian coast (North Adriatic, Croatia) showed that up to 10 m depth, nearly 28% of the total length of the soft calcareous limestone structures has been bared. The micro topography of intact and harvested limestone surfaces was measured by means of five metric and angular variables as indicators of structural complexity. The comparative analyze of variance and the PCAnalysis relative to single stations allows distinguishing not only the intact from damaged profiles but also permits to differentiate the rank of the demolition impact. Besides, the biometry and specific density and the relative size/age frequency of date shell sampled from different substrates, demonstrated that as consequence of heavy harvesting their population structure is also significantly weakened. To conclude: date shell harvesting radically distress the rocky bottom communities, following by a general degradation of the original biodiversity, but in particular perturbs the population structure of the same date shell as well.

Keywords: *Lithophaga lithophaga*, Croatia, indicators

Restoration of boreal forests and forest-covered mires

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The aim of the EU LIFE-Nature project is to safeguard the favourable conservation status in 33 Natura 2000 areas in Finland. The favourable conservation status is safeguarded by restorating 5 000 hectares former commercial forests, by restorating 350 hectares drained forest-covered mires and 300 hectares eskers with closing canopy and by maintaining 170 hectares deciduous forests for white-backed woodpeckers. Forests will be restorated by burning, by making small openings and by adding the volume of decaying wood. The aim of restoration actions is to add missing features of natural forests to formerly managed forests. Such features are deciduous trees, decaying and burnt wood. Light conditions will be optimised and the volume of decaying wood will be increased in forests with white-backed woodpeckers by doing small openings and by felling or damaging standing trees. Ditches in mires will be filled or dammed; thus, the mire will return to waterlogged state, the peatlayer will start to grow again and the plant and animal species of the mires will return as well. Evaporating trees, appeared after ditching, will be felled or cleared, if necessary. Esker forests will be restorated by small-scale prescribed burning or openings and by increasing volume of decaying wood. Thus, the exposure to sun and the features of natural forests will be increased. At the same time, the restoration methods for esker forests will be developed. Duration of the project is 61 months: 1.12.2003-31.12.2007. The project is financed by EU LIFE-Nature, Metsähallitus, Karelia Brigade, University of Joensuu, UPM-Kymmene and WWF.

Keywords: Burnt wood, decaying wood, ecological restoration, LIFE-Nature, small openings.

Ecofeminism Applied to the Resolution of the Wolf Reintroduction Conflict

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Environmental ethics has much to share with our exploration of contemporary environmental issues. While theories of environmental ethics may not give us a specific solution to the issue we face, they do provide a framework through which issues can be more carefully and thoroughly investigated. Ecological feminism is one such environmental ethic. Considering the wolf reintroductions that occurred over a decade ago in the western US, I will show how the theory of ecological feminsim helps clarify points of dispute, affected viewpoints, and potential resolutions to challenging conflicts.

Keywords: Reintroduction, wolf, ethic.

Macrofungi proposed to be protected by law in Hungary

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Macrofungi conservation raise a lot of problems in practice which does not appear in case of plant and animal conservation: establishing their habitat and area, periodicity and fluctuation of fruitbody development, lack of mycological investigations in several parts of the country etc. Red Data List of Hungarian Macrofungi was published in 1999, after several preliminaries. The number of endangered species with IUCN 0., 1. and 2. values is 456, out of these 16 "extinct", 103 "critically endangered" and 337 "endangered". Based on this list a material concerning 30 macrofungi species proposed to be protected by law was submitted to the Authority for Nature Conservation by the Hungarian Mycological Society. There were two main points of view of selection: 1/these species must be endangered, and 2/must be easily manageable by nature conservation specialists. The main reasons of endangerment were 1/habitat degradation and destruction and 2/conspicuous habit. In the case of successful protection of these species (based on management plans) the number of protected macrofungi can be increased in the future.

Keywords: macrofungi, endangerment, protection

Protecting invisible streams: ecological values at the land-water interface

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Rivers and streams originate from a myriad of small streams and wetlands that are so small that most do not appear as blue lines on topographic maps. While these small headwater streams remain invisible they are often considered insignificant and are highly vulnerable to modification from land-use and management changes (e.g., urbanisation), and re-engineering (e.g., channelisation, piping, and damming). We require knowledge of the extent, biodiversity values, and function of these small streams that dry up for part of the year to assess the relative importance of ephemeral streams compared to perennial streams and to develop management strategies to protect them. In the Auckland Region, New Zealand, we surveyed 165 sites in 32 catchments to determine the spatial extent of ephemeral streams, and sampled the aquatic fauna at 12 streams. The study sites were in three land-use classes: pasture, native forest, and pasture with riparian restoration planting. Samples were taken in winter and summer at perennial or "blue-line mapped" streams and upstream within the ephemeral area. Taxa richness in ephemeral streams was generally similar to the perennial stream. Sensitive taxa (EPT taxa) were found even in mud samples, where the stream had dried up, in native forest or restored pasture streams, but not in open pasture streams. Ephemeral forest streams were also habitat for large terrestrial dragonflies, and pools harboured native fish and crayfish. Early indications suggest that small streams have ecological values at least as important as those of perennial streams and hence warrant increased management for biodiversity protection.

Keywords: land-water interface, ephemeral headwater streams, riparian restoration.

The management of ectomycorrhizal symbioses: a key factor for the success of ecological restoration of mine sites in New Caledonia.

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The common occurrence of large nickel ore deposits within the lateritic regolith, makes New Caledonia the fourth largest producer of nickel ore worldwide. In these nickel-rich environments, quite unique metallophyte ecosystems have developed with a very specific and rich flora (endemic at more than 80%). In the framework of a mining project, the Koniambo Massif (Northern Province), we studied the role of the plant and associated ectomycorrhizal fungal communities within these metallophyte ecosystems. Surveys conducted since 2001 have shown the importance of ectomycorrhizal plant species in these natural

ecosystems. They have also highlighted the exceptional diversity of some fungal ectomycorrhizal taxa, particularly within the genus *Cortinarius* considered scarce in the tropics, though already known from temperate and arctic ecosystems for its abundance and diversity. Fungal diversity was confirmed through molecular methods analysing the 5.8S rRNA genes, showing the occurrence of these fungal taxa in the host plants root system, as well as directly in the soil. These ectomycorrhizal symbioses are essential to insure soil particle's cohesion, thus preventing water erosion. The use of ectomycorrhizal symbioses has to be considered as a key factor in the success of ecological restoration of mine sites.

Keywords: Ecological restoration, Ectomycorrhizal fungus diversity, Metallophyte, Nickel

Spatial flood management in river basins and opportunities for ecological restoration of floodplains in a European context

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This project considers and investigates the concept of combining a more spatial and natural way of coping with flooding incidents in and along European river systems with possibilities for restoring conservation values. The restoration of original floodplain functions could enhance flood control and thereby alleviate unwanted inundations of other areas within the same catchment basin. Restoration of biodiversity values lost over centuries of ever-increasing human land use and river control would seem an evident by-product. However, since man restricted river dynamics to narrow, embanked winter beds, land use and landscape design have been intensified so much, that simple reversion of river access to former floodplains may not always be a key to successful ecological restoration, even when international EU laws are actually supporting such actions. Moreover, the presence of source populations of rare and relatively immobile species of plant and animal has often become so restricted that re-colonisation will be difficult or even impossible. In fact, it is argued that a sound restoration of original natural riverine processes and corresponding biodiversity on local, regional (catchment) and continental scale levels is only likely to be achieved through careful studies of the local particularities of each case and taking into account existing conservation values as well as potentials. Some case studies are presented as examples of what can be learnt.

Keywords: river flooding, risk reduction, floodplain restoration, EU policies, conservation benefits

Transfer of Microelements Within the Chain "Soil – Water - Grass - Cow" at the Territory of Intensive Industrial Pollution and a Possibility to Produce Ecologically Safety Product

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In the presentation we discuss the measures that allow to reduce or prevent the everyday impact of inorganic contaminants on the animals on the contaminated aria (considering town Karabash, Chelyabinsk region of Russia as an example). Analyzed are flows of microelements in the chains "water-soil-grass-cow" and role of enterosorbent Bifezh® as an effectively protector against penetration of such microelements as Ni, As, Cd, Cr, Cu, Pb, Co in internal of the cows. It is discovered that the elemental composition of cows' milk at the contaminated territory doesn't contain increased levels of all controllable microelements (above background level) even in the case the internal contain extremely elevated levels of the same chemical elements. The results of experiments on the prevention of microelements penetration the animals with forage and water are discussed in details. Estimated distribution coefficients for more the 25 microelements between enterosorbent and different organs of cows are considered and discussed on the background of the model of mass-transfer in the system "water-soil-grass-cow".

Keywords: non-ferrous metals, contamination, cow, food chain, enterosorbent, protection.

Vegetation Succession in Ecosystem Restoration: Relative Importance of Environmental Factors

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The role of site environmental factors driving succession, both abiotic and biotic including human interference, has been many times discussed in ecological literature. From the point of view of restoration practice it is often a crucial question how do the factors influence establishment and growth of species, and to answer it properly, may substantially increase effectiveness of restoration activities. It can help to decide if it is possible to rely upon spontaneous succession, how and when to manipulate it, or when technical reclamation is better to adopt. In our analysis of the higher number of successional seres, we found substratum pH and climate to have significant influence on the course of succession. In an experimental study, when various substrata were transported to one site, substratum character was responsible by ca. 80% for the rate of formation of vegetation cover in initial successional stages. Moisture of the surface layer of the substrata was obviously the most important factor. In several other our studies, participation of target species in a disturbed site was significantly dependent on the sources of diaspores in the close (up to 50m) neighborhood of the site. Comparing own data with literature, it can be concluded that site moisture, substratum pH, nutrients, macroclimate, and sources of diaspores can be considered as the most important environmental factors driving spontaneous succession.

Keywords: Climate, species pool, spontaneous succession, substratum, technical reclamation.

Ecological Restoration of the lower Ebro river

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The last 50 Km of river Ebro still maintain conditions close to the good ecological status with the presence in the river of endangered species like *Margaritifera auricularia*. After the abolition of the Ebro river transfer from National Hydrological Plan (NHP), alternative measures have been proposed for the preservation and restoration of the river health. These include the restoration of one meander with low flow due to hydroelectric derivation of the waters, the construction of a fish laden in two small dams, and the restoration of the riparian corridor. But these "in situ" measures may be insufficient because the actual river regime (regulated for hydro electrical purposes and with low flows due to agricultural abstractions), the poor water quality originated from agricultural and urban discharges in the basin (high nutrient content and risk of chemical pollution) and the abundance of invasive species (*Silurus glanis, Dreissena polymorpha*) are the real cause of the degradation of the ecological status of the river. According to the NHP these disturbances will be increased in the future and therefore "in situ" restoration measures may insufficient to maintain or increase the river ecological status.

Keywords: River restoration, Riparian forests, Basin management, Ecological status.

Nature is neither a thing nor an accumulation of things. It is neither external nor internal, it does not surround us, it is not, it cannot be destroyed nor can it be loved

Prigann H.

Birkhäuser – Publishers for Architecture. Basel.Berlin.Boston

Ecological aesthetics is creating a basis for a shift in perspective. Current problems in the world around us are seen as creative issues of artistic environmental design. Art and landscape architecture are aiming their concepts and work at finding productive viewpoints that go beyond prettification or formalistic design. Based on a vigorous intellectual exchange with research in the humanities and natural sciences, they engage in a processual dialogue with the laws, materials and forms of nature. This book describes the diverse aspects of ecological aesthetics from the point of view of artists, landscape architects, scientists, philosophers and politicians. A special place among the work presented, by over fifty international artists and landscape architects, takes the landscape art of Herman Prigann, who also initiated this survey. Environmentally aware landscape design is faced with new problems today. These include the recultivation of derelict industrial land, redesigning urban areas and restoring river regions, but also dealing with former open-cast mining areas and devising viable concepts for agriculture and forestry at a time of radical change in these fields. Current design efforts reach beyond the surface to recreate our cultural landscape fully and effective-

ly. Numerous tendencies in landscape architecture, science and theory have driven research and landscape transformation for over thirty years. Approaches as different as Art in Nature, Reclamation Art, relational aesthetics, syntactic landscape design and advanced concepts about art and science working together are united by a search for dialogue with natural processes. It is their aim to recall the interaction of nature and culture and to gradually continue this process. The Spanish based German landscape artist Herman Prigann has developed central categories of ecological aesthetics in his works and concepts: his path, which the book also follows, leads from metamorphic objects via sculptural places and landscape transformations, in the Degussa-Hülst chemical park, for example, or the Rheinelbe Sculpture Park, to an integrative landscape art. Over a hundred projects by artists and landscape architects from the USA, Japan, Germany, Denmark, France, Great Britain, the Netherlands, Switzerland, Spain and Italy present the broad conceptual repertoire of an ecological aesthetic whose designs focus on natural processes of growth, destruction and renewal. They are responding to man's longing for the untouched, his need for identity, orientation and presence, but also to the necessity for a paradigm shift in art, landscape architecture and environmental design.

Restoring degraded spawning habitats

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There is nearly no river in Central Europe without forms of regulation and habitat degradation. Additionally land use in these watersheds has changed dramatically within the last centuries causing consequences like erosion, mobilisation of nutrients and pollutants. Coevally most of the rheophilic and lithophilic fishes (fishes of streaming waters, gravel bed spawners) are seriously threatened. Degraded spawning habitats rank among the main reasons for the decline of fish stocks especially in the rivers' upper parts. This degradation is mainly caused by fine sediments clogging gravel beds and by a lack of dynamic gravel due to regulations. This study describes how spawning habitats for gravel bed spawning fishes can be restored. It introduces methods to manage already suspended matter allowing sufficient spawning grounds to develop. To find the base for these methods the watershed of a regulated river with degraded and non degraded spawning grounds was mapped and examined. Geologic formations, erosion, sediment transport, sedimentation, and land use were compared with the river's sediments andmorphology via GIS analyses. Sufficient spawning grounds were examined in consideration of sediment quality, interstice-oxygen, sedimentation, morphology, hydrology and reproduction success. The thus found information was used to construct artificial spawning grounds mainly by arranging hydraulic conditions and by gravel management. Then these spawning sites were monitored regarding acceptance by fishes, spawning success and sediment quality.

Keywords: restoring rivers, gravel bed spawners, land use, river morphology, sediment dynamics

Restoring Wild Landscapes in Cornwall (UK): Cultural Heathland and Wild Forest landscapes are Sustainable Elements

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Wild open expanses of heathland were typical of the historic cultural landscape that once covered over 80,000 hectares of Mid–west and North Cornwall (UK). Pan–European economic changes during the 19th and 20th centuries devalued the social and economic worth of heathland causing a 90% loss so that only about 7,000 hectares remains in Cornwall currently. In the Mid-Cornwall region the China Clay industry involves extraction of kaolin from open-cast pits with consequent surface tipping of waste. The mining industry was historically a major contributor to the loss and disruption of heathland landscapes. The tipping remains active in 2005 so that there is an overriding need to re-create a wild open landscape encompassing the character and biodiversity that previously existed. The China Clay industry, and in particular Imerys Minerals, have been working with public sector partners since 1997, to restore and re-create a landscape that has at its core cultural relevance, economic sustainability and ecological viability. The starting point for the landscape restoration were field experiments, first established in 1976, which tested a range of heathland restoration techniques and provided protocols for reliable and successful heathland re-creation. In 1995 the first large scale (50ha) re-creation of heathland on china clay mineral waste was commenced. A dislocated rural landscape is being progressively restored to heathland (750ha) and wild wood underpinned by small fields bounded by Cornish hedges at lower elevations. Ultimately the restored landscape will only be sustainable if it is intrinsically linked to economic activities that support the development of human recreation, tourism, agricultural niche markets and small-scale forestry products.

Keywords: Heathland, integrated landscape, China clay wastes, social and economic sustainability.

Small-scale environmental heterogeneity and spatial patterns of seedling emergence and survival in a mountain environment (Sierra Nevada National Park, Spain)

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Environmental heterogeneity is critical for ecosystem structure and functioning, yet it has barely been considered when restoring degraded ecosystems in Mediterranean areas. We evaluated the spatial patterns of emergence and survival of two woody species, *Quercus ilex* and *Sorbus aria*, as well as those of environmental variables, in three landscape units: pioneer shrubland, pine plantations and autochthonous forest. We quantified spatial patterns using the spatial analysis by distance indices (SADIE) methodology, and used a variation partitioning method to identify environmental variables associated with seedling survival patterns. Emergence and survival, as well as most environmental variables evaluated, showed an aggregated pattern in the three landscape units evaluated. Patterns of seedling emergence and survival were significantly explained by some of the environmental variables evaluated (soil compaction, light availability and soil moisture). Our findings contribute to the understanding of the linkages between the spatial heterogeneity of environmental factors and the response of plant populations in mountain Mediterranean areas, and can be used to optimize their restoration.

Keywords: seedling survival, spatial pattern, environmental variables, mediterranean forest.

"Cities and Oceans of If"

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Objectives: 1. Using art as a primary restoration science investigative tool. 2. Designing more efficient overlays with built infrastructure that could revivify former biological hot spots, 3. Creating overlapping circular wildlife habitat linkages in relation to water, 4. Investigating areas where small linkages and peripheral edges might be re-established to reinforce pockets of wildlife refuge. 4. Methods: In my ecological art work, "Cities and Oceans of If', 2000- present, I have studied over a dozen international sites in various stages of urban decay for their geomorphic relationships to large water bodies and traditional patterns of indigenous animal and plant migrations. This research and design evolved from studying the large landscape effects and parameters of a small wetlands restoration on a fishing island in the Gulf of Maine: "Ghost Nets" 1990-2000. This paper will present theoretical results of this extended work, including at Bergen Belsen, Germany, Liverpool, England, St. Louis, Missouri; reviewing them as case studies and discerning rehabilitative relationships between sites. Tools have included historical maps, GIS, sound art, painting, photography and conventional biological monitoring. Results: Strategies were developed for long term sustainability even when implementation was delayed. The overarching products of application of these tools resulted in concrete addresses, from zoning for city planning to experimental modeling. Conclusion: Speculative science can be driven by the tools of art as art may be driven by environmental intuition. Art and science parity result in strengthened vision. Provocative questions at the heart of restoration can be revealed and answered by imaginative teamwork.

Keywords: Art, restoration, urban, wildlife

Mangrove Forest Restoration in Godavari mangroves of Andhra Pradesh, India

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Restoration of degraded mangroves is being carried out in the tropical and subtropical estuaries throughout the World. M.S.Swaminathan Research Foundation (MSSRF) and Andhra Pradesh Forest department have restored the degraded mangroves in the Godavari and Krishna wetlands in Andhra Pradesh, India. The causes of degradation of mangroves are both anthropogenic and natural. The change in the topography is an important cause of degradation and the mangroves of this estuary has been restored by digging shallow canal in the degraded areas and mangrove saplings were planted. This paper deals with the causes of degradation and the strategy followed in the mangrove restoration.

Keywords: restoration, mangrove, India

Forest corridors linking species, habitats and people from Atlantic Forest, Brazil

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Fragmentation is among the major threats to the Atlantic Forest hotspot. In the distribution area of endangered golden lion tamarin (Leontopithecus rosalia) - the lowland forests of the Rio de Janeiro State - loss of habitat from 1986 to 2002 reaches an average rate of 1,2% per year. As a result, tamarins are being isolated in small and unsustainable subpopulations. To avoid the effects from fragmentation and to establish a minimum viable population of 2.000 wild tamarins, the Golden Lion Tamarin Association is working on forest restoration and protection. Besides that, the involvement of local governments and communities are crucial to ensure the long term results. Using an integrated approach of landscape ecology and flagship species, the habitat connectivity has been restored through the establishment of forest corridors among isolated fragments. Using native species of trees (n=66), the first corridors were planted within private lands in 1997 and its use has been documented for tamarins and birds. The corridor currently being implemented will connect Poço das Antas Reserve - the biggest protected subpopulation of tamarins (n=260), to the Rio Vermelho Ranch, a private farm that shelters reintroduced tamarins. This corridor will link 21 patches of forest crossing over 26 cattle ranches, covering a distance of 30 Km, making available around 3.000 ha of habitat. Forest corridors has been effective linking fragments, providing dispersion routes and restoring genetic flow, enlarging the effective size of available habitat, involving the local governments and private landowners in the restoration of the landscape and its biodiversity.

Keywords: Atlantic Forest, golden lion tamarin, landscape ecology, habitat restoration, forest corridors.

Considerations to restore *Avicennia germinans* stands in the subtropical semiarid coast of Puerto Rico

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This study examines key factors that modulate the establishment and development of *Avicennia germinans* in hypersaline soils to pursue management strategies for its restoration and conservation. The study was carried out in two sites, a disturbed site called Mar Negro and a control site, Aguirre. Physical, chemical and biological factors were measured during a year. An estimation of seed production and retention in different inundation levels were done. *A. germinans* seedlings were cultivated in three salinity concentrations to evaluate their tolerance. Plants that survived these treatments were planted in the study sites and monitored for six months. Salinity in sediments was significantly different between sites except during the driest and wettest month. Salinity changed from 30 to 165 PSU (particles salinity units) in Mar Negro and from 16 to 33 PSU in Aguirre. At the control site 0.4 seed/m^2/year were established meanwhile, the establishment in Mar Negro was zero. The saplings survivorship was 96% in Mar Negro and 54% in Aguirre during the wet season. After two months of dry season it diminished to 75% and 13%, respectively. Factors as inundation and salinity must be controlled and seed production and recruitment must be improved to guarantee seedlings establishment and plants development. Intensity and duration of wet and dry seasons have a main role in *A. germinans* survivorship and growth. A report of *Junonia evarete* larvae feeding on *A. germinans* was made for first time to this location. Larvae herbivory make plants susceptible to high salinities and inundation levels.

Keywords: *Avicennia germinans*, herbivory, disturbed mangroves, subtropical semiarid mangrove, *Junonia evarete*.

Forest restoration experiences in tropical mountains: a Metanalysis in Mayan indigenous territories of Chiapas, Mexico

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The highly divese tropical mountain forests of southern Mexico (>500 tree species in areas >1500 m elevation) have been severely fragmented and floristically impoverished due to landuse changes caused by Mayan peasants over the last 40 years (coffee plantations, shifting agriculture, new human settlements). Natural regeneration processes from the remaining stands may be limited because of scarcity of reproductive trees, fruits, and seeds of most species, along with drastic changes of the regeneration habitats.

We propose a development strategy aimed to maintain (even increasing) the extent of forest fragments within a matrix of deforested habitats. We have learned how to propagate 135 native tree species in nurseries operated under rustic and low-cost conditions, and have monitored over the last decade the performance of 16,484 young individuals of 60 species planted in more than 70 plots. Autoecological studies allowed us to propose four functional groups: conifers (eight species), oak species (11), shade-intolerant broad-leaved trees (20), and shade-tolerant broad-leaved trees (21). Tolerance to shade conditions, which interacts with soil water availiability and other factors, appears as the main driver of plant survival and growth along evapotranspiration gradients. Our results reflect the widespread operation of local ecological processes such as facilitation and tolerance. We propose that a model of the regional dynamics of the landscape matrix may attempt, drawing on establishing diversified local plantations that could enhance natural regeneration processes, the reconciliation of forest conservation with traditional and commercial use of forests by the indigenous communities.

Keywords: Native trees, plant functional groups, shade tolerance, Tropical Montane Forest.

Comparison of selected exampled of dry reservoirs in France and Poland. Influence of design choices on mitigation efficiency, river ecosystem and landscape

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Engineer activity in a river bed should be a part of a general management project of the whole catchment. Technical solutions have been designed to re-create natural functions in artificial reaches, such as irregular cross-sections with pools and rifles, varied bank slopes and roughness. The topic of this paper is to transfer this experience to dry reservoir design: we characterized effects of existing dry reservoirs on aquatic habitats and propose means to alleviate them. In the first part, we describe examples of dry reservoirs in France and in Poland. They range from 5000 m3 to several million m3, and were built from a few years to one century ago. These mitigation structures, with an open culvert through the dam, are expected to maintain the ecological river corridor and flow pattern. Their effectiveness and the possible impacts on the habitats are presented. In particular, the culvert is an artificial stretch, and depending on its shape and the water depth it can hinder or not animal migrations. In a second part, means to alleviate the negative effects are discussed. In particular, the influence of the inlet geometry and resulting velocity in the culvert are discussed for both floods and normal flows. The visual impact must not be forgotten, and some suggestions are proposed. The possible adaptation of dry reservoirs to maintain a permanent small water body seems a good idea but is not easy to achieve. Dry reservoirs have proven their efficiency for flood mitigation, and a few precautions could make them almost harmless to the river ecosystem – which is not always the case in the examples studied.

Keywords: Dry reservoirs, main channel continuity, flood mitigation, catchment integrated management

Forest Landscape Restoration in Mediterranean forests: Case studies from biodiversity valuable forest landscapes in Western Mediterranean

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The joint WWF/IUCN Forest landscape restoration (FLR) concept aims to restore forests within functional conservation landscapes, in order to secure the environmental stability and viability of the natural systems and the socio-economic benefits they produce under a sustainable rural development scheme. WWF, in partnership with governmental institutions, land owners, land users (local community groups), NGOs, research groups and intergovernmental organisations, is developing pilot FLR initiatives to prevent and reverse the current trend of biodiversity loss and degradation in priority forest landscapes of south-western Mediterranean countries (Southern Portugal mountains; The Rif and the Middle Atlas mountains in Morocco). WWF is embarked in a multi-stakeholder process to get endorsement from governments for adopting FLR as a policy and operational instrument to support forest protection and sustainable management, and to create appropriate mechanisms for allowing effective participation of all concerned parties in decision-making, planning and implementing FLR. A network of pilot restoration initiatives and actors to share know-how and strengthen north-south collaboration is being created.

Keywords: Forest landscape, Mediterranean region, ecological restoration, spatial planning, public participation, policy instruments, trade-off mechanisms.

Sustainable Approach to Environmental Sanitation: Dry Ecological Toilets in Nepal

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Justifiable and reasonable use of water resources is the call of the day. Drinking water is a serious concern for the people. While many countries in the world are facing chronic shortage of water, waterborne sanitation has become an unrealistic option. Use of water for flushing excreta is not only a senseless matter but also a crime, because 40% of the World's population is deprived of the drinking water facility whereas the urban population use excessive quantity of water to flush the excreta. Existing inadequate sewerage system and direct disposal of household waste into the watercourses has tremendously multiplied the water pollution. This will continue further if the needful is not done immediately. Eco-Toilets are feasible in the rural and peri- urban areas to reduce the consumption of costlier water that is required for flushing. As the conventional treatment technologies require high investment and operation and maintenance cost, the Eco- toilets that can be dealt with limited financial resources are the only suitable option left for sanitation for the 21st century.Our preference should be sustainable, ecological on site systems based on local materials and appropriate technology. To reduce the environmental degradation and overcome this problem, Eco toilet is only the realistic option in the context of Nepal. This work has used appropriate technology and studied their performances in the context of Nepal with full involvement of local people. Two Lab scale reactors, one exposed to sunrays and the other without sunrays were constructed to replicate the vault to collect the faeces. In sunrays model, it was found that in 48 days of observation the faecal coliform presence depleted to 610 cells per gm from the initial value of 7×10E10 and the volatile organic matter came down to 70.18% from 98.09 %. Similarly, in the other model the destruction of faecal coliform in 65 days was found to be 920 cells /gm while the destruction of organic matter took 75 days. The faeces got decomposed in one and a half month's period compared to the general case of 3 to 4 months. Also from the observation on 313 people of a cluster of the pilot project; annually recovered value of N, P and K was found to be 1565 kg, 125 Kg, 344 Kg, respectively. The research work, thus found the dry Ecological toilet to have a clear advantage over the traditional water borne sanitation. This paper presents an in-depth review of present scenario of efficient water demand management of Kathmandu, the performance evaluation of the Waste Water Treatment Plants as Stabilization ponds, and Oxidation Ditch of the Kathmandu valley of Nepal; similarly this paper deals with the different types of Dry ecological toilets, their performances and feasibility study in the context of Nepal, based on complete laboratory analysis and the regular monitoring. The result advocates the implementation of ecological toilets to save the valuable water wasted in flushing as well as the resources used to treat the waste.

Keywords Ecological Sanitation; Ecological Toilet, Excreta Reuse, Sustainable Sanitation.

Is biomanipulation an alternative for restoring the eutrophic Laguna Alalay?

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Laguna Alalay is an urban shallow lake in the city of Cochabamba (Bolivia). Despite actions taken in order to improve lake water quality (sediment dredging and construction of a sewage system) Laguna Alalay is still eutrophic and shows a turbid-water state. Our study aimed at determining *i)* the factors controlling phytoplankton densities and *ii)* whether biomanipulation may potentially cause a shift to a clear-water state. We carried out nutrient-deletion and fractionation experiments (monthly during one year) to test for nutrient limitation and zooplankton grazing on phytoplankton, respectively; and one enclosure experiment to test for the effect of zooplanktonic fish on the planktonic community. Our results show that N is the main limiting nutrient for phytoplanktonic growth all year round, with P being often co-limiting. Zooplankton grazing had no effect on phytoplankton densities except in one case, when cladocerans were more abundant. The zooplankton community structured in the absence of zooplanktivorous fish reduced significantly phytoplankton suggesting that the trophic cascade effects of fish exclusion may result in higher lake water transparency and a shift to the clear-water state.

Keywords: Urban lake, eutrophic, biomanipulation, zooplankton, phytoplankton.

Natural restoration of degraded hillyland ecosystem in Southern China

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We examined 20-year trend of natural restoration of a degraded hillyland ecosystem in Southern China. The results showed hillyland community was in low-grade level dominated by herbaceous and arbuscular plants, although some trees had invaded in 1997. The available phosphorus in the degraded hillyland had reached the available phosphorus content of zonal vegetation, the monsoon evergreen broad leaved forest, and the organic matter and available potassium was near to the level of zonal vegetation, but the hydrolysable nitrogen yet need a long time to restore. Compared with climax, only available phosphorus was near to the level of monsoon evergreen broad leaf forest in Dinghushan in 1995; Some ecologic function had been restored, among which earliest function restored was water and soil conservation in 1993-1996, and other functions still need more time; For the normal regressive system, such as the Heshan degraded hillyland, water and soil erosion could rapidly reached the level of dominant community, the other functions of ecosystem were difficult to restore in short time by natural restoration, furthermore, soil fertility could be restored 20 years later by natural restoration, and the restoration of degraded hillyland ecosystem could be accelerated by constructing suitable artificial forest ecosystems.

Keywords: degraded hillyland, natural restoration, heat balance, surface runoff, water and soil erosion, soil fertility

Reforestation of Mediterranean abandoned cropland with contrasting *Quercus* species

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In abandoned Mediterranean croplands, establishment and growth of woody plants are limited by high radiation and low water availability during summer, and weeds are strong competitors for resources. We conducted a 3-year experiment in central Spain to study the response of three *Quercus* species (*Q. coccifera, Q. ilex* and *Q. faginea*) that differ in their habitat requirements under four treatment field conditions resulting from the combination of full-light vs artificial shading and weed presence vs weed mowing. We measured seedling survival, resprouting capability and growth, weed production, microclimate (PAR, air temperature, soil water evaporation, and effective precipitation), and soil moisture. Shading and weeds reduced PAR reaching the seedlings and soil water evaporation. Shading and mowing increased soil moisture. We found a clear positive synergic effect of shading and mowing on seedling performance. Weed competition limited seedling survival in all species more than high radiation, whereas the relative importance of these factors in limiting growth depended on the growth measure and species. As hypothesised, the effects of stress release on plot cover were most noticeable in *Q. faginea* –the most mesic species- and least in *Q. coccifera* –the most xerophytic species. The release of weed competition allowed *Q. ilex* seedlings to invest resources in above-ground and, apparently, in below- ground growth. Shading increased simultaneous growth in diameter and volume only for *Q. faginea.* It is important that planted *Quercus* seedlings in abandoned Mediterranean cropland take advantage of a low competitive environment from weeds during the period before the first dry season.

Keywords*:* Evaporation; relative growth rate; soil moisture; weed competition.

Constraints on the Colonization of Limestone Quarry Floors by Alvar Vegetation

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A seed-addition experiment was conducted at four abandoned limestone quarries in Ontario, Canada, to better understand forces controlling the colonization of quarry floors by vegetation from rare, species-rich limestone pavement ecosystems called alvars. Natural succession on abandoned quarry floors can sometimes follow an alvar trajectory, and alvars may therefore serve as useful reference systems in quarry restoration. Preliminary comparisons of biophysical features on alvars and quarry floors suggest that establishment of alvar species at quarries may be limited by immigration barriers, substrate deficiencies, and competition with quarry residents. To investigate the effects of these potential constraints, 216 quarry plots were seeded with grass and forb species under six treatments, and the richness and abundance of established alvar species were measured to estimate colonization success. After one growing season it was found that untreated plots performed similarly when seeded with either common quarry weeds or alvar natives, indicating that seed limitation does constrain quarry colonization by alvar species. Alvar-

seeded plots performed better when pre-treated with either herbicide or sand and peat moss than when left untreated, indicating that both competition with quarry residents and substrate composition limit colonization success. Alvar species establishment was neither improved by nitrogen addition nor diminished by seed-addition of potential competitors, indicating that the quarry substrate is not nitrogen deficient, and competition with within-cohort quarry weeds is less important than competition with established quarry residents. The observed establishment of alvar species following minimal site alteration supports that alvars may be valuable reference systems for quarry restoration.

Keywords: Quarry rehabilitation, limestone pavement, seed limitation, substrate limitation, competition

Combining water storage and nature development Sediment dynamics and –quality in the Beerze brook valley, The Netherlands

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Surface water storage is seen as an important measure to deal with peak discharge problems in streams and drought stress. However space is limited in the densely populated Netherlands. Therefore emphasis is laid on combining water storage with other land use functions such as nature. This paper focuses on the influence of controlled flooding on soil properties in a recently developed water storage and nature development area along the brook 'De Beerze' in the Netherlands. During the winter season parts of the area are flooded for 100 to 130 days. In the winter season of 2003/2004 and 2004/2005 sedimentation was measured using sediment traps along transects straight on the stream. To compare the composition of the sediment with the soil, soil samples were taken of the rooting zone (15 cm) under each sediment trap. The sediment and soil samples were analyzed on grain size, nutrients and heavy metals. The first results showed, relatively high sedimentation rates compared to natural flooding systems, varying from 0.18 kg/m^2 far from the stream to 45.44 kg/m^2 close to the stream. Organic matter and nutrient content in the sediment close to the stream (OM 0.6%, N-tot 0.25 g kg^{-1} and P-tot 0.23 g kg^{-1}) was in all cases lower than found in the soil (OM 3.5%, N-tot 0.74 g kg^{-1} and P-tot 0.31 g kg^{-1}). After a few meter from the stream the organic matter and nutrient content in the sediment (at 10 m from the stream: OM 12.9%, N-tot 6.81 g kg^{-1} and P-tot 2.49 g kg^{-1}) exceeded the content in the soil (at 10 m from the stream: OM %, N-tot 1.75 g kg^{-1} and P-tot 0.43 g kg^{-1}). The heavy metals showed the same trend. At this moment the sediment measurement of the flooding season 2004/2005 still need to be processed. We expect to find a same pattern for the sedimentation rate and composition as shown in the first year. For the long term this means that the conditions within the first few meters of the stream turn into a more nutrient poor environment and eutrophication in the rest of the flood plain.

Keywords: Water storage, Sedimentation, Nature development

Twenty Acres Down and Two Hundred Thousand Acres To Go: Large-scale Restoration of Degraded Agricultural Lands in the San Joaquin Valley (California)

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California's San Joaquin Valley represents the region with the greatest number of threatened and endangered species in the United States (excluding Hawaii). This condition is due, *at least* in part, to the widespread conversion of the original habitats to agriculture and urban development. The western San Joaquin Valley is generally ill-suited for agriculture, as the lands are characterized by high groundwater, poor drainage, and high concentrations of heavy metals and salts. Hence, a significant portion of the area's agricultural land has been targeted for retirement. Currently, approximately 70,000 acres have been retired, with an additional 130,000 acres targeted for future retirement. Since 1998, we have been conducting a pilot project (ca. 2000 acres) in which we have been monitoring the impacts of land retirement on the biota. Increasingly, our research has focused on *developing approaches to* effectuate *the large-scale re-conversion of these lands to native-dominated communities.* Restoration in the study area has been problematic, as the site is characterized by *poor soil* conditions (e.g., high salinity, elevated nutrient levels from long-term agriculture), limited rainfall (ca. 25 cm./year), and a depauperate native seed bank. Additional challenges have come from the surrounding retired lands, which have proven to be an overwhelming source of plant and insect pests. Nevertheless, some areas have been successfully restored

to native habitat, although not yet in a manner that would approximate historical conditions. Ongoing research is particularly focused on seed-delivery methods and various forms of weed control. Initial results from trials using pre-emergent herbicides in conjunction with mechanisms designed to minimize the impacts of these herbicides on native species have been particularly promising.

Keywords: arid lands, agriculture, restoration, endangered species

"Defining spatial and temporal sampling strategies for river depth"

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Detailed hydromorphological surveys are often carried out to describe physical habitat characteristics for hydro-ecological investigations and to appraise river restoration projects. Fieldwork for these surveys is time consuming and expensive, yet little work has examined the most suitable sampling strategy for field data collection, or evaluated which parts of the stream are the most sensitive to changes in flow. This study aimed to assess the accuracy of three different sampling strategies (i.e. regular transects, random grids and stratified grids) for predicting depth at non-measured points, and to identify which mesohabitats and flow types better characterise depth changes due to variations in flow. Depth, mesohabitat and surface flow type measurements were collected at 2583 points for two different flows (Q=0.517m^3/s and Q=0.344 m^3/s) on the Leigh Brook, Worcestershire, UK. Geostatistical techniques were applied to predict depth values at non-measured points for each flow and for each sampling strategy. Eight different indicators (variogram, mean squared error, mean error, R-squared, residual plots, frequency distributions, cross-sections, mapping resolution, standard error maps) have been analysed to identify the differences between sampling strategies. The results show that depth changes due to flow changes are mainly located at shallow and deep glides habitat types. The analysis for the comparison of sampling strategies indicates that grid sampling strategies, either random or stratified, give better results than regular transects. Since the results also show that higher errors in predictions are obtained in deepest areas (pools-deep glides), higher sampling densities should be applied in these locations.

Keywords: depth, hydromorphological sampling strategy, geostatistics.

The consideration of environmental and ecological criteria in planning and design of land restoration in mining projects. The case of Las Cruces Mining Project

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The Las Cruces Mining Project consists on a high-grade copper deposit, located in the municipalities of Gerena, Guillena and Salteras (Seville, Spain), that will be mined as an open pit mine and copper cathode will be produced on site using an hydrometallurgical process. Environmental concerns have been integrated from the beginning into the planning and decision process on mining project. The Restoration Plan has been prepared taking into account environmental and landscape planning concerns and limitations, and ecological criteria have been incorporated, whenever possible, into restoration design of mining areas. The Mining Project has included some design measures to help progressive rehabilitation (zoning and land-surfaces configuration with landscape criteria, natural topography recreation, topsoil management). Rehabilitation approach has been adapted to the future mining areas and the conservation and protection values of the natural environment. The weight of ecological criteria considered in restoration design is variable depending on the ecosystems to be reconstructed or rehabilitated (streams, mediterranean forest, agro-steppe). The Restoration Project of fluvial-stream and forest ecosystems is focused on hydrological correction, topsoil restoration and afforestation by means of natural vegetation, which is almost extinct because of traditional and intensive agricultural land uses.

Keywords: restoration planning, mining projects, habitat reconstruction

Restoring 42 urban areas of concern in the Laurentian Great Lakes

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Laurentian Great Lakes Areas of Concern (AOCs) are defined by the U.S.-Canada Great Lakes Water Quality Agreement as "geographic areas that fail to meet the general or specific objectives of the agreement where such failure has caused or is likely to cause impairment of beneficial use of the area's ability to support aquatic life." The U.S. and Canadian governments have identified 43 such areas (one has been restored) primarily in the urban centers. These are locations where significant environmental degradation is likely to cause continuing impacts to the Great Lakes, twenty percent of the world's fresh surface water. The Agreement directs the two federal governments to cooperate with state and provincial governments to restore each AOC. Three beneficial use impairments—degraded fish and wildlife populations, loss of fish and wildlife habitat, and degradation of benthos—pose problems for restorationists because the chemical, physical and biological impairments have accumulated over more than a century in heavily populated and industrialized areas. In order to carry out restoration consistently across all AOCs, we used the Society for Ecological Restoration International's Primer to lay out a pathway to develop goals, site specific targets and project designs. This paper will describe AOC restoration-related problems, outline the restoration pathway, and give examples of how that pathway is being implemented at specific AOCs.

Keywords: Laurentian Great Lakes, Great Lakes Water Quality Agreement, International Joint Commission, Areas of Concern, urban restoration, beneficial use impairments.

Native legumes and *Bradyrhizobium* species – essential partners in revegetation programs

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Mutualistic associations between plants and soil microorganisms are essential for plant survival and growth in most terrestrial ecosystems. In particular, the symbiosis between legumes and rhizobia is one of the most ubiquitous interactions and the most important natural route to introduce reduced nitrogen into the biosphere. The restoration of heavily disturbed habitats will be facilitated and accelerated by the re-introduction of both plants and their mutualists. The aim of this study was to evaluate the effect of inoculation with native *Bradyrhizobium* strains on the growth of six Iberian shrubby legumes in natural soils from central western Spain. Shrubby legumes were selected because they are key components of natural Mediterranean ecosystems and good candidates for revegetation programs. They exhibit a relatively high growth rate, high drought tolerance and ability to perform in soils with extreme values of pH. Plants were grown in non-treated soils and in soils from which soil microorganisms were removed, and with or without rhizobia inoculation. Plant growth was hindered by the lack of soil microorganims, and inoculation with native rhizobia significantly enhanced plant growth. We conclude that the inoculation of seedlings before transplanting into the field provides a good way to re-introduce native rhizobial strains in the disturbed soils and to enhance plant survival. The results highlight the importance of positive interactions with soil microorganisms for plant growth and advise the use of native organisms as inoculants in revegetation strategies.

Keywords: *Cytisus, Genista, Retama*, Mediterranean ecosystems, biological nitrogen fixation.

Methodology for the Rehabilitation of areas degraded in the location Fat Tip

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The present work titled Methodology for the Rehabilitation of areas degraded in the location Fat Tip has as main objective to rehabilitate the areas affected by the mining activity, leaving of the analysis of the influence of the actions that affect the natural means. During the development she/he is carried out the description of the environment and of the project of Exploitation, identifying the actions that produce impacts on the environment, as well as the measures of prevention and mitigation of the same ones; the basic approaches of the recovery works settle down in the affected areas, describing the technical preparation of the land and their biological rehabilitation, including among other the selection of the species; the environmental impact is determined that will produce the methodology of proposed rehabilitation, as well as the evaluation of the environmental impacts that you/they take place and the socioeconomic

evaluation of these works, also settling down the pursuit measures and environmental control in the closing stage and abandonment.

Keywords: rehabilitation, mining, evaluation.

The re-creation of species-rich wetlands on former arable land: the roles of long term phosphorus fertilisation and phosphorus species

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The re-creation of wetlands in former agricultural areas in Western Europe often results in strong eutrophication and development of an explosively growing, species-poor vegetation type (mainly *Juncus effusus, Glyceria fluitans* and lemnids). In some cases, however, a species-rich vegetation type establishes within a few years. Field investigations indicated that soils of the first type appeared to be non-calcareous with phosphorus mainly bound to iron(hydroxide)-complexes. As a result, the drop in the redox potential following rewetting leads to iron reduction and concomitant mobilisation of high amounts of phosphate in the soil. For the second type, the soils were more or less calcareous and phosphorus was mainly bound as calcium-phosphates (probably as apatite). As calcium-phosphates are not influenced by a low redox potential, phosphate remained immobilised following rewetting. Field and laboratory experiments indicated that on phosphorus saturated, non-calcareous soils, biodiverse wetlands can only be succesfully restored after the removal of the phosphorus saturated topsoil and/or by the addition of lime.

Keywords: arable land, eutrophication, phosphorus species, restoration, wetlands.

An adaptive management approach to restoration of urban vegetation

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Botanic Gardens and Parks Authority (BGPA) in Western Australia has custodianship of significant urban vegetation in the Perth metropolitan area: Kings Park (267ha) and Bold Park (437ha). These remnants have been subjected to land-use pressures and disturbance phenomena that have led to their severe degradation: frequent fires, recreational activities and weed invasion. Consequently, they are undergoing restoration via a number of research programs encompassed in a larger project examining restoration protocols for urban vegetation in Western Australia. To devise appropriate prescriptions for restoration, and to enable timely application of practical research outcomes, the BGPA has adopted an "*integrated research*" and "*adaptive management*" approach involving intimate links between BGPA science disciplines (weed ecology, seed/propagation science, conservation genetics, germplasm storage, restoration ecology), and operations staff; as well as industry, community groups, and government agencies. To highlight an example, BGPA's science team is now guiding management to enable 'good practice' restoration of Bold Park. The Bold Park 'Environmental Management Plan' commits BGPA to restoration of this degraded Park - currently representing one of the most significant and challenging urban restoration projects being undertaken in Australia. To facilitate the project, several areas of intensive research were highlighted as pivotal to restoration success. As such, the Bold Park restoration research program involves integration of BGPA's science disciplines and strong links between science, managers, operations, community groups and stakeholders, with the expected outcome being restoration of Bold Park to a more diverse and healthy ecosystem. This presentation will provide an overview of project results to date.

Keywords: Urban remnant vegetation, restoration, adaptive management, integrated research.

Restoring ecological connectivity after the impact of transportation infrastructures

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Habitat fragmentation is one of the most outstanding impacts of transport networks in the landscapes and it has been identified as the main cause of biodiversity loss in Europe. Loss, disturbance and pollution of wildlife habitats, fauna casualties and dispersal of exotic species are some of the ecological effects of roads and railways, but their barrier effect, that difficult the wildlife movements across the landscape,

is a major threat for the long term conservation of wildlife populations. First step for minimising these impacts, and the basis for the restoration of ecological connectivity, is the identification of the habitats which concentrate a high biodiversity, and the ecological corridors which allow the dispersal of individuals, the exchange between different nucleus of metapopulations and the accessibility to all resources (food, refuge, etc.) needed for the long term conservation of healthy populations. Between the measures that must be considered we highlight the importance of the route design, that must avoid the fragmentation of key habitats and ecological corridors. A second step is the construction of wildlife crossing structures such as big landscape bridges and fauna passages. Monitoring and evaluation of the effectiveness of these structures have provided a good knowledge of the requirements of different species and the information collected all around Europe have been compiled in the handbook *COST 341.Wildlife and Traffic. A European Handbook for identifying conflicts and designing solutions.* Location, dimensions, and conditioning of the entrances of wildlife crossings are key points for guarantying their effectiveness. At present, the challenge is to achieve the awareness of decision makers and professionals involved in the design and construction of transport infrastructures and promoting the best practices for the avoidance of habitat fragmentation and the restoration of ecological connectivity.

Keywords: Habitat fragmentation, transport infrastructures, restoration, ecological connectivity.

Restoration trial with *Austrocedrus chilensis* (Cupressaceae) in Patagonia, Argentina

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The aim of this study was to carry out a restoration trial on approximately 5 hectares of hillside originally covered in pure *A. chilensis* forest, located near the Nahuel Huapi National Park. The entire area had been burnt and then illegally felled. Its recovery is important, particularly due to its location, in order to halt soil erosion and protect the basins. Various sectors are taking part in the study: (a) the private sector, represented by a company providing the study area; (b) the government, represented by Servicio Forestal de la Provincia de Río Negro (Río Negro Province Forest Service) supplying plants and logistic support; and (c) Universidad Nacional del Comahue, designing and monitoring the trial and organizing activities for environmental education in the local community. Firstly, vegetation cover, natural regeneration of *A. chilensis* and percentage of bare soil were assessed. During winter 2004, 3000 trees were planted. Results show that 4 years after the fire, shrub cover is high (54%) and the site has 50% bare soil. Although natural regeneration of *A. chilensis* has been low (< 1 sapling / hectare), preliminary results indicate that survival is related to the presence of shrubs and herbs, which facilitate its re-establishment.

Keywords: Temperate Patagonian-Andes forests, Restoration, Fire / felling.

Long term studies in restoration ecology of heathlands and sand dunes in Brittany

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The managers (ONF, CG, DRAC) ask us about restoration after trampling or introduction of exogen species on heathlands and littoral sand dunes. The monitoring studies from 15 years show the ecological conditions of **restoration** in the two cases but the actual challenge is to propose a durable way of **management including the perturbations** like trampling or grazing. The evaluation of ecosystem **resistance and resilience** of the vegetation in front of perturbation is an important stage. The landscape role is very important, in terms of transfer of species, of seed bank, and other functioning elements. We transfer to the manager an evaluation of the **tolerance** for each perturbation and indicators for their own evaluation. The long term monitoring is necessary because the restoration could be long and after we must survey the changes, only fluctuations are allowed. The difficulty in terms of immediate scientific “rentability” of long term studies must be confront to restoration ecology goals.

I think it is easy to find supports for this research from managers of habitats, but it is difficult to have scientific people, our scientific instancy (CNRS) do not integrate our difficulties.

Impact of flooding on the productivity of the vegetation

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Changes in climate and increased problems with flooding of downstream (often urban) areas have led to the perception that retention of water in upstream areas is needed in the Netherlands. Restoration of the natural flooding regime in upstream areas might be useful to increase both the water retention capacity and the nature value. However, it is uncertain what the effects of increased flooding will be on nature conservation areas, because the surface-water quality is often very poor. To investigate the impact of flooding on the productivity and species composition of nature conservation areas five sites along small rivers in the Netherlands were studied that are regularly flooded with surface water and have a similar vegetation management (they are used as hay meadows). Soil and vegetation were sampled and analysed in a transect perpendicular to the river. The results show that flooding intensity and surface water quality have little influence on the productivity and species richness of the vegetation. Species-rich hay-meadows (*Molinion*-vegetations) and sedge-vegetations (*Magno-Caricion*) can exist in places that are regularly flooded with nutrient-rich water. The results suggest that sedimentation and the input of nutrients with sediment are the decisive factor in regulating the productivity of the vegetation. The most productive vegetations are found in places closest to the river, with a high amount of clay and a high amount of heavy metals, indicative for recent sedimentation. Probably because of the high input with sediment phosphorous is not limiting in the floodplain areas investigated.

Keywords: *flooding, productivity, vegetation, small rivers.*

Mangrove Abundance, Diversity and Restoration in Dege Ecosystem

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A study to restore and diversify mangrove species was carried out in Dege mangrove ecosystem, south of Dar es Salaam. Three sites 1, 2 and 3 with different levels of degradation were selected. Ten seedlings each of three species of mangrove were transplanted in eight rows in each of the three sites. The survival, health status and growth rates of all seedlings were assessed over a period of fifteen weeks. Mangrove diversity and abundance of all tree, saplings and seedlings of each mangrove species were determined in eight plots in each site. As an indication of degradation, all stumps in each plot were counted and measured. Abiotic factors were also measured in each plot. Results indicate that, mangrove species diversity and basal area were higher in site 2 compared to site 1 attributed to variations in cutting pressure and substrate organic matter. One of the three mangrove seedlings showed faster growth rate than others in all sites. Survival and health status of transplanted seedlings were higher in site 2 compared to site 1 due to variations in substrate organic matter and canopy cover, influencing changing in substrate temperature and salinity. With increasing population, the paper recommends raising public awareness about mangrove ecosystem and introducing alternative income generating activities to reduce overexploitation of mangrove resources. It also emphasizes on community mangrove restoration monitoring programs.

Keywords: Mangrove, diversity, restoration, Dege.

Land-use effect on the $C0_2$ flux over a woodland-savanna continuum across the Orinoco llanos

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This work analyses the effects of land-use on the CO_2 transfer across a woodland savanna continuum in the Orinoco lowlands. Thus, the carbon aggregation capacity of various stages of savanna re-growth (*i.e.* a cultivated field of *Andropogon gayanus,* a herbaceous savanna, a tree savanna and a woodland) following disturbance were evaluated by using eddy covariance and mass balance techniques. The conversion of a native woodland biome to pasture resulted in carbon efflux to the atmosphere an equivalent to 63 percent of the carbon storaged in the system (4514 g cm^{-2}). Particularly land-use extended a major impact on the soil organic carbon stored in the woodland soil (2764 g cm^{-2}), which was reduced to 1538 g cm^{-2}. Results on the diurnal patterns of canopy CO_2 flux densities for the increasing stages

of carbon aggregation show that during the wet season, the stands incorporated carbon from 7:30 to 18:00 hours. However, the course and magnitude of the canopy $C0_2$ flux differed over the stands. During the sunlit hours, the measured $C0_2$ flux density was in phase with the daily trend of net radiation. Greater CO_2 flux densities were observed over the woodland canopy, even though trees use apparently less efficient C3 photosynthetic pathway. As mid-afternoon proceeded and evening approaches, CO_2 flux over all stands converged and become null. During the night-time, the CO_2 efflux densities from the stands were slightly invariant with time, and the herbaceous savannas lost CO_2 at a slightly greater rate than that in the other stands. Maximum rate of CO_2 uptake approached -18 µmol m^{-2} s^{-1} over the woodland. For all stands, nocturnal CO_2 efflux ranged from - 3 to - 7 µmol m^{-2} s^{-1}. These densities were circa 56 - 72 percent of peak day-time $C0_2$ uptake rates. Daily integration of the measured flux generated seasonal averaged daily values over the pasture-field, herbaceous savanna, tree savanna and woodland savanna of - 0.034, - 0.025, 0.042 and - 0.050 MJ m^{-2} day^{-1}, respectively. The time courses of canopy $C0_2$ flux density were parabolic on sunny days. The woodland assimilated $C0_2$ at a higher rate than the other stands. LAI and biodiversity were major communities variables that affect the CO_2 flux. Increase in LAI during the wet season enhanced the stand's sink strength for $C0_2$. However, seasonal changes in LAI explained partially the temporal variation in CO_2 flux densities.

Keywords: *Andropogon gayanus*, Orinoco, woodland.

Natural flow variability to preserve fish species critically at risk: a Spanish case study

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It has become increasingly evident that we are living in a period of unprecedented biodiversity lost. The Jucar river watershed (Spain) harbors a high number of endemic mussel and fish species that are declining or going extinct at an alarming rate. Factors affecting Chondrostoma arrigonis (a fish specie critically at risk) were analysed to explain the decline of his populations. Despite upper parts of rivers are less affected by diffuse and point source pollution and land use, flow modification that includes significant water abstraction, regulation works and others hydromorphological alterations, was selected as the major factor governing the threat processes.To understand the local extinctions across their range, physical habitat degradation was assessed using the computer-based Physical Habitat Simulation System (PHABSIM) by comparing river reaches with different flow modification histories. To reverse the negative impact on biological diversity, critical flows of the natural regime were identified to reestablish proper habitat conditions and the whole ecosystem functionality. Our findings indicate that heavily flow modification activities may result in long term decline and reduction in aquatic diversity, regardless of setting minimum flows for the river. From the perspective of the ecological restoration principles, environmental flows to maintain natural diversity and functionality of ecosystems may require conservation of key hydrological components of the natural flow regime.

Keywords: endemic fish, risk of extinction, habitat management, natural flow regime.

Some factors influencing natural plant colonization as a part of coastal sand dune restorations in Northern Spain

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In 1984 the Spanish government started restoring sand dunes in the northern coast of the Iberian Peninsula. The techniques employed were a combination of biodegradable sand fences and *Ammophila arenaria* and *Elymus farctus* plantations with a random distribution. Following the processes of restoration, further plant colonization naturally occurs and this is an important part of the overall process that influence the build up of the dune resilience. Colonization can be influenced by three main factors, that is: the human influence, the restoration processes and the natural conditions of the site. In this work we have analysed the process of plant colonization following the restoration and some environmental conditions of restored dune systems. We have monitored several dunes during four years and found that the colonization process is not a steady one and that it is specially influenced by the fluctuations in the rate of sand accumulation.

Keywords: sand dunes, restoration, *Ammophila*, plant colonization.

Adaptive restoration and the assemblage of wetland communities: The importance of long-term approaches

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The Doñana marshes are an iconic example of the problems posed to conservation areas by development activities in their close neighborhood. Simultaneous to its declaration as a National Park and MAB Reserve, agricultural development resulted in the drainage of two-thirds of the marsh surface and the loss of three out of four water inlets. The Park managers have struggled since them to deal with chronically insufficient water inflows, poor water quality and overgrazing by feral cattle. As a consequence, the Doñana marshes are severely degraded, with rampant problems of sediment deposition, wetland eutrophication and an accelerating process of invasional meltdown. In an ambitious effort to correct this situation, the Doñana 2005 project aims at restoring the quantity and quality of the water inflow, and recovering formerly-drained marsh areas. Although the project has adopted an adaptive approach in which the interaction between engineers, managers and scientist is actively sought, it is faced by the inadequacy of baseline data. Doñana is one of the best studied natural areas of Europe, but the multitude and varied nature of pressures and stressors that have influenced the marsh ecosystems complicates the identification a "baseline" state, free of severe human influence. Moreover, historical effects and time*treatment interactions hamper the interpretation of temporal series in both restored and reference ecosystems. This case study will be used to discuss the necessity of long-term data that take into account the influence of man-mediated disturbance; the potential strategies to disentangle time*treatment effects following restoration; and the potential choice of large restoration areas as valuable sites for Long-Term Ecological programs.

Keywords: wetland restoration, adaptive management, reference sites, time*treatment interactions, long-term ecological research.

Ecological Restoration of Over Exploited Lobster Populations of Gulf of Mannar, India

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Among the crustacean resources of Indian seas, lobsters are known for their delicacy and high price both in domestic and export markets. Among 6 species of lobsters distributed both in the east and west coasts of India, 4 species viz. *Panulirus homarus, P. ornatus, P. versicolor* and *P. longiceps* are common in the Gulf of Mannar which is located in the south-east coast of India and is the only marine biosphere reserve in this region due to its diversified and unique fisheries resources including coral reefs, pearl oysters, sacred chanks, sea horse, sea cucumbers, sea cow, etc. The lobster populations are under great threat in recent years due to over exploitation and the catch has dwindled from 998 tonnes in 1998 to 142 tonnes in 2000. In order to restore the population, the following ameliorative measures need to be undertaken. Strict enforcement of fishing holidays which is in vogue for 45 days from 15th April to 31st May for mechanized fishing vessels; avoidance of capture of baby lobsters; use of traps with mouth adjustment; ban on the use of entangled nets and fishing in and around coral reefs. Apart from these, population enhancement measures such as popularization of fattening techniques in baby lobsters among entrepreneurs and production of lobster larvae in laboratories and their sea ranching. Further, installation Fish Aggregating Devices in rocky zone to serve as lobster sanctuaries and ban of lobster fishing in such areas would help the matured lobsters to breed and enhance their population in the vicinity. Presently the lobster catch is restricted to 80m. As the deep sea lobster potentials have not hitherto been trapped, crafts and gears have to be modernized to undertake fishing of deep sea lobsters.

Keywords: Gulf of Mannar, lobsters, over exploitation, enhancement measures.

Strategies of Ecological Restoration through Puerto Rico Forest Stewardship Program

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The Puerto Rico Forest Stewardship Program provides technical assistance to landowners in the development of management plans and integral conservation of the natural resources (private forests) on their land. These management plans provide the documentation and direction which are necessary to identify, describe and plan specific actions for the protection, management, improvement and restoration of soil and water resources, aquatic and terrestrial wildlife, natural forests and/or plantation, esthetic value and recreational potential. The method to carry out our objective is implementing a several strategies of ecological restoration to achieve the short, middle and long term environmental benefits. Despite its small area (2,199,238 acres) Puerto Rico has a high level of biodiversity, which contributes significantly to biological richness of the Caribbean area. Actually, these strategies are in function by one hundred four (104) final management master plans which representatives around 4,500 acres into the five (5) high priority watersheds in the Puerto Rico Island. Our expectative for the next five (5) years is to impact 1,000 acres into the water sheds each year. The establishment of these ecological restoration strategies will contribute to protect and conservation of natural resources by incorporating the affected communities in planning, management and improvement the quality forests resources of Puerto Rico.

Keywords: landowners (private forest), ecological restoration strategies, management plans, watersheds.

Efficacy of a Nature-like Bypass Channel in a Portuguese Lowland River

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Throughout Europe, in the last decade, there has been a steady shift away from more technical fish pass designs to more nature-like passes, such as nature-like bypass channels. Upstream fish passage in a nature-like bypass channel was investigated in a lowland river, the Lima River, at 117 days, from March 2000 to May 2002. Fish passage was recorded using an automatic video recording system. Electrofishing samples within the bypass and below the weir were compared with species abundance found in the tape recordings. More than 7500 individuals of 8 species passed the bypass channel. Species composition was dominated by striped mullet (65.3%) and potamodromous species (34.3%), which used the bypass mainly at night. Of the environmental variables considered, bypass discharge explained most of the variation in cyprinid numbers, whereas water temperature was more important for diadromous species. Comparing species composition below the weir, with passage recordings, provided a useful tool to assess species efficacy of the bypass, although biological requirements, should also be taken into account. This study proved the efficacy of the bypass in passing almost all occurring species and life stages and also in providing suitable habitat for fish fauna, highlighting the use of these facilities for river restoration schemes.

Keywords: Nature-like bypass channel, weir, upstream migration, cyprinids, habitat, efficacy.

Armenia: a lot to do for conservation and restoration of landscapes

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Armenia is a new independent country, a small part of the former Soviet Union. It shares all problems specific for developing countries, both economic and social. At the same time Armenia is a land of ancient culture, its population is highly educated and has a rich background, particularly in the science. Now our country is on the difficult way of renewing its potentialities. Armenia joins three geological-botanical regions (Caucasian, Iranian and Eastern Mediterranean); the biodiversity within this modest geographical region is impressive and includes a number of endemic species. The country territory presents a variety of landscapes and habitats and is a crossroad of species migration and matching. During transition period mentioned Armenian landscapes were endured serious perturbations. Now it is the high time to restore and enrich our habitats. This problem involves legislative, scientific and other ends, implies the population ecological awareness and joining efforts of Armenian and international ecologists. Our review will include brief notes on legislative ecological activity in Armenia and some other aspects of landscape preservation. The main discussion will be paid to scientific problems and will summarize Ar-

menian scientists' achievements, especially in the field of the protection and restoration of animal biodiversity and habitats.

Keywords: Armenia, conservation, restoration, landscapes

A System to Evaluate the Quality of Biological and Ecosystem Restoration Objectives: Using National Wildlife Refuge Comprehensive Conservation Plans as a Case Study

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It is widely accepted that plans for restoration projects should contain specific, measurable, and science-based objectives to guide restoration efforts. The National Wildlife Refuge System of the U.S. Fish and Wildlife Service (FWS) is in the process of developing Comprehensive Conservation Plans (CCP) for the more than 500 units in the System. These plans contain objectives for biological and ecosystem restoration efforts on the refuges. Based on FWS policy, a system was developed to evaluate three critical factors for these objectives. 1) Is the objective specific, measurable, achievable, results-oriented, and time-fixed? 2) What is the extent of the rationale that explains the assumptions, logic, and reasoning for the objective? 3) How well was available science used in the development of the objective? The evaluation system scores each factor on a scale of 1 (poor) to 4 (excellent) according to detailed criteria. The biological and restoration objectives from CCPs published as of September 2004 (60 total) were evaluated. The overall average score for all biological and restoration objectives was 1.73. Average scores for each factor were: Factor 1 - 1.97; Factor 2 – 1.86; Factor 3 – 1.38. The overall scores and the scores for each factor increased over the period of analysis (1997-2004). Future restoration efforts may benefit by using this evaluation system during the process of plan development, to ensure that biological and restoration objectives are of the highest quality possible prior to the implementation of restoration plans, and to allow for improved monitoring and adaptive management.

Keywords: Ecosystem, habitat, objectives, restoration, wildlife refuge.

Naturalization of sown meadow communities and biological diversity restoration in Lithuania

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Under temperate climate conditions natural and sown meadows are unstable ecosystems ascribed to intermediate stages of succession of plant communities. According to the data on land use of the Republic of Lithuania, meadows and natural pastures cover 7.5 % of the country's territory. In order to solve the problems of landscape formation and protection of vegetation it is necessary to consider the preservation of the optimal areas of natural or semi-natural vegetation (including meadows) and their restoration. The long-term scientific research data on sown meadow communities in Lithuania were analyzed, trends on the increase of meadow communities' diversity and the decline of economic profit under insufficient management conditions were revealed. A positive correlation between the diversity of plant species and the age of sown meadows (r=0.84) indicates, that species diversity in communities increases with the age of grassland. The number of vascular plant species in sown meadow communities approximates to that of natural meadow communities during 30–35 years. However, the species included into the Red Data Book of Lithuania are rarely found there. The cessation of pasturage and mowing in meadows enables gradual overgrowth with shrubs and trees that is the case in Lithuania. This process became evident after the change of land use and decreased agricultural activities in recent decade. However, it is expected that the EU structural fund support facilitate the restoration and conservation of meadow communities.

Keywords: sown meadow, community succession, naturalization, restoration, biological diversity.

Agri-environmental measures for restoration of agricultural landscapes - Estonian approach

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In Estonia the development of the Agri-Environmental Program (AEP) began in 1997 and the implementation of the AEP in pilot areas was launched in 2001. In 2004 several measures were launched in full scale. Some measures (establishment, restoration and maintenance of landscape elements; feeding areas

for migrant birds; management of semi-natural habitats) are directly linked to landscape restoration. The intensive farming and extensive land improvement of the Soviet period resulted in a simplification of the traditional mosaic-like landscape structure: large masses of fields were established from which stonewalls, which used to be valuable habitats, were removed; coppices and other valuable landscape elements were also removed from fields. As a result, habitats suitable for many species of agricultural lands were destroyed and the aesthetic value of landscapes suffered. By 2004, evaluation and monitoring methodologies of AEP had been elaborated and tested. This paper summarises the Estonian AEP applied in 2001-2004 and presents selected indicators of biodiversity and landscape. The main focus is on the analysis of selected indicators of landscapes. 12 pilot areas of the AEP were investigated.

Keywords: Agri-environmental measures, landscape restoration, landscape monitoring.

Senna occidentalis L.: A native plant to restore the natural vegetation of islamabad.

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Biological invasion by alien species is now recognized as one of the major threats to native species and ecosystems, yet awareness of the problem is alarmingly low. *Parthenium hysterophorus* L., an alien invasive species, is spreading through out Pakistan. Worldwide it has been designated as one of the most troublesome weed. Ever since this weed had become a menace in different parts of the world, several methods have been recommended in containing the growth of *P. hysterophorus*. However, none of these appear to be satisfactory, as each method suffered with one or the other limitations such as inefficiency, high cost, impracticability, polluting the environment, temporary relief etc. It was noticed in the field that *Senna occidentalis* is replacing *P. hysterophorus* gradually in patches. Aqueous extract of *S. occidentalis* in different ratios were applied to check the germination and early growth of *P. hysterophorus*. *C. occidentalis* at different concentrations showed least germination of *P. hysterophorus* and a significant gradual depression in fresh biomass accumulation was noted. *Senna. occidentalis* and *P. hysterophorus* both are competitive weeds of wastelands. In view of health hazards and likely threats to biodiversity due to *P. hysterophorus*, it is probably advisable to promote *S. occidentalis* growth, which is harmless medicinal plant in Parthenium infested areas.

Keywords: Alleopathy, *Senna occidentalis*, parthenium weed, phytochemical control

Ecological Restoration and Protection of Degraded Mangrove Wetlands Ecosystems in the Sundarbans

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Sundarbans, a delta of rivers Ganges and Brahmaputra is the world's largest coastal wetland shared between Bangladesh 62 percent and India 38 percent. Enormous amount of sediments (2.3 billion tons) carried by the two rivers contribute to it's expansion and dynamics. Representing the interface between land and water systems, they are among the most biologically rich ecosystems in the coastal area of Bangladesh and also the most endangered. When water contaminated with high salinity and other particles, the ecological diversity of the wetlands can seriously threatened. Sundarbans mangrove wetlands are fragile ecosystems, vulnerable even to small changes in their composition of biotic and abiotic factors. The Sundarbans landscapes was affected by different community groups and human actions, some of which are now abandoned. The degraded water and soil are used for mangrove afforestation and biological fencing. Construction of some polder, coastal mangrove afforestation programme and Sundarbans biodiversity conservation project (SBCP) are created wetlands habitat which is turn is reviving fauna and flora slowly. Admittedly certain species net extinction while some other exit are still as red listed species. Sundarban reserve forest coupled with tourists influx has influenced it's biodiversity and ecology. GIS using in surface saline water model simulations would be the appropriate tools for decision making to prepare a long term plan for restore the threatened mangrove wetlands in Sundarbans. The model simulations will also be used to evaluate the effects of possible restoration measures for sweet water development ecosystems. Mangrove wetlands conservation is increasingly becoming significant in the Sundarbans region in Bangladesh as more coastal community particularly the rural dwellers derive their lively support from wetland resources. Successful restoration may require setting realistic restoration goals and understanding constraints imposed by the surrounding landscapes.The paper also highlights the processes of integrating wetland watershed in the management plan gained in mangrove vegetation de-

velopment and shrimp farming and towards protect the wetland ecosystems, and restore the Sundarbans mangrove ecology.

Keywords: Mangrove, Wetlands, Ecosystems, Ecology, Saline Water, Management, Habitat and Restoration.

The importance of genetic considerations for planning translocations in the rare heathland species *Boronia rivularis* (Rutaceae)

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Boronia rivularis is a rare heathland shrub restricted the Sunshine Coast of Australia, an area undergoing rapid urbanisation. A development proposal is planning to translocate a population of this species from the southern end of its range. A previous study of genetic diversity in *B. rivularis* found a nearby population to be highly inbred and genetically depauperate compared with other populations. The study also found that, inbreeding was significantly positively correlated with population density. The population on the development site was mapped using a differential GPS and identified dense and sparser subpopulations and was used for initial translocation planning. We sampled the development site *B rivularis* within four sub populations using the same methods and markers as the previous genetic analysis. This study revealed genetic diversity was high in some subpopulations but progressively decreased as plant population density and fixation indices increased across the site in the direction of the neighbouring depauperate population. The large population size and the genetic structuring suggest the nearby population may have arisen from this one and highlights the benefits of retaining some of the existing population on the site. The results also indicate that any compensatory translocation program needs to mimic this the genetic substructuring. Largely due to its lower density, the subpopulation with the highest diversity and lowest inbreeding had not been previously valued as highly for translocation as the more conspicuous denser subpopulations. This study has highlighted that high population density does not necessarily indicate genetically fitter or more diverse subpopulations.

Keywords: population translocation, compensatory habitat, plant density, genetic diversity, inbreeding.

Malls, Mosquitos and Muck: Historical Ecology and Urban Wetland Restoration

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This paper examines the spatial structure of human, natural and physical patches in the jurisdictional area of the New Jersey Meadowland District (NJMD) and analyzes how they interact and change through time to identify appropriate restoration targets. As a case study, this estuarine wetland complex provides a dramatic example of landscape change within a large, urban, regulatory unit. Located within one of the busiest and most intensely developed transportation corridors on the continent, this 30 square-mile management area contains 8,400 acres of wetlands and open space. Since early European settlement in the 17th century, this landscape has changed dramatically from ecologic mosaic consisting of freshwater cedar swamp, fresh and salt marshes to a largely brackish marsh system dominated by *Phragmites australis*. Our study correlates and analyzes historic data through a GIS, compiled from secondary archival sources including botanic holdings, government documents, colonial diaries, land deeds, maps and photographs. Preliminary results indicate this dramatic change relates to general physical landscape changes such as land subsidence, sea-level rise and climate variability; as well as more direct anthropogenic change such as wetland drainage for agriculture and mosquito abatement, real estate development and large-scale landfill. Because the landscape has changed so dramatically, reference ecosystems are not obvious. For example, some restoration regimes seek to eliminate *Phragmites australis* in restored systems. Our work indicates the existence of the species within the historic ecosystem, suggesting the species may have a place -in appropriate proportion-within restored plant communities.

Keywords: urban wetlands, restoration, historical ecology, *Phragmites australis.*

Restoration of Degraded Lands of Central Aravallis of Rajasthan Through Integrated Ecological Management Plan (IEMP)

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Central Aravallis, an ecotone between North-West arid and South-East agroclimatic zones of Rajasthan in India has been damaged due to disturbances of mining, deforestation, soil erosion and plant invasions and resulted in loss of biodiversity, soil and nutrients. Long-term studies (1992-2003) on degraded lands of 25 sq km area, fenced by the Forest Department, was conducted for applicability of Integrated Ecological Management Plan (IEMP) based on species response, soils and operative factors. IEPM consists of four elements:1. Revegetation of pioneer species (Rev-P), 2. Regeneration of dominant trees (Reg-T), 3. Retention of dry matter (Ret-D) and, 4. Redundancy of invasive plants (Red-S). Results demonstrate that for Rev-P, *Cenchrus setigerus* and *Panicum antidotale* are most suitable pioneers on excavated Ca+ rich and Fe++ rich soils with NPMg amendments. This increases phytomass of two grasses up to >10 and >6 times respectively. This follows with colonization of legumes (*Indigofera quadrifolia* and *Tephrosia purpurea*) and herbs. *Anogeissus pendula* is an appropriate tree for regeneration and its protected stands showed high phytodiversity (Reg-T). Dry matter (litter + partially decomposed OM) is retained within the system through bowl trenches on slopes (Ret-D). This could check flushing of soil and nutrients. Invasive plants like *Prosopis chilensis*, *Lantana camara*, *Eucaluptus* sp and *Parthenium hysterophorus* were discouraged in the protected stands (Red-S). Thus heterogeneity in vegetation is developed to reduce competition for resources. It is concluded that the process of restoration could be speeded with IEMP along with other parameters discussed in the paper.

Keywords: Restoration, degraded lands, Central Aravallis, Ecological Management.

The influence or organic matter addition on growth of arbuscular mycorrhizal fungi in plantations of eroded slopes in Nepal

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Nepal is very prone to soil erosion but rapid restoration of vegetation of eroded sites can help control the surface erosion. Many plants form symbiosis with arbuscular mycorrhizal (AM) fungi and these fungi are important for the uptake of mineral nutrients from the soil and they enhance the amount of water stable soil aggregates in the soil producing glomalin (a glycoprotein that glues soil particles together). We investigated the role of organic matter or P amendments on development of arbuscular mycorrhizal (AM) fungi in eroded slopes in Nepal. Different types of organic matter was mixed with eroded soil and the mixture was placed in mesh bags (50 µm mesh) that allowed fungal colonisation but not root colonization. The mesh bags were buried in the eroded site either between June and December (Wet season) or between December and June (dry season). The amount of the AM specific fatty acid 16:1ω5, the amount of AM spores and the amount of glomalin in the mesh bags was quantified. The organic materials had a strong positive influence on the amount of AM biomass and the number of AM spores during the wet season (June to December) while very low AM growth was detected during the dry season. The AM specific fatty acid 16:1 ω5 was positively correlated to the amount of glomalin indicating the positive role of AM fungi on stabilizing the soil which will reduce its proneness to erosion.

Keywords: Arbuscular mycorrhiza, glomalin, eroded site, Nepal.

Post-fire restoration: Design of the building phase and projection of post-fire dynamics using matrix models of species substitution

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The project of restoration of native plant communities after a forest fire occurred in “Puerto de Las Palomas” (Natural Park of *Cazorla, Segura y Las Villas*, Jaén province, August 2001) intends to develop and apply procedures based on the natural dynamics of Mediterranean vegetation. Specifically, we seek to hasten the secondary succession using facilitation processes. Recent studies revealed that such processes sustain the natural regeneration of woody species typical of intermediate successional stages (building

phase). To identify such species, and characterise plant-plant interactions in the study area, we surveyed vegetation recovery in a nearby area burned 17 years ago. We surveyed the vegetation in 110 plots of $25m^2$, noting the presence of woody species' recruits beneath 'nurse plants'. We considered that a recruit could eventually replace its nurse when the recruited species had a larger adult size, and/or when it occurs in later successional stages. Thus, we characterized plant-plant interactions as: facilitation (recruit can replace the nurse), indifferent (recruit and nurse of similar size and successional status; we assumed that each plant had a 50% chance of taking the space), or no-interaction (recruit growing in open interspaces). We built a species substitution matrix with the frequency of plots where each interaction occurred. The state vector was the current frequency of woody species. This allows us to: estimate the frequency of interactions taking place during secondary succession; identify conditions prompt to collapse succession; and project the natural regeneration dynamics after fire. Results will inform the design of the building phase to implement in future restoration works.

Keywords: Secondary succession; facilitation; building phase.

Phoshate as a key factor for nature restoration on former arable land

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Recent nature policy in the Netherlands has as goal to transfer more than 150.000 ha of arable land into nature. The main problem is achieving nature adapted to nutrient poor conditions. Due to fertilisation the arable land mostly contains a large amount of nutrients. We evaluated four management practices that are used for reducing nutrient availability on sandy soils in order to facilitate the establishment of low-productive plant communities: 1) sod cutting in combination with grazing, 2) sod cutting in combination with mowing, 3) grazing and 4) mowing. For each management practice we selected three locations where it was considered successful and three locations where it failed, according to the managers of the nature reserve, as judged by the failure establishment of target species that are typical of low soil fertility and undesirable high fertility and ruderal species. Comparison of the actual vegetation with target communities revealed few species typical of nutrient poor conditions were present on most of the locations. Sod cutting in combination with mowing resulted in most target species. Grazing was least successful and resulted in the most undesirable species. On most sites biomass production was N limited. High values of N/P (>10) typical for low productive species rich grasslands were only found on soils with P(water) < 4 mg P_2O_5/l soil or P-Al < 3 mg P_2O_5/100 g soil. N, P and K biomass concentrations revealed a strong relationship between phosphorus availability and the success or failure of restoration management. This indicates the need for effective management practices for reducing phosphorus availability in the soil.

Keywords: Low-productive vegetation, sandy soil, sod cutting, grazing, mowing, former agricultural use

Floodplain sedimentation regulating vegetation productivity on small rivers?

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Sediment input and associated nutrients were quantified along a vegetation gradient from the small river channel to the floodplain margin in five nature reserves along four small rivers; the Dommel, the Drentsche Aa, The Reest and the Overijsselse Vecht in The Netherlands. The amount of sedimentation during the flood season of 2003-2004 was measured using sediment traps. Grain size and nutrient analysis were carried out of the trapped sediment samples. To characterize the soil and vegetation, an inventory of both was included in the research. The biomass of the vegetation is different for all investigated areas and varies between 900 g/m^2 and 200 g/m^2. With distance from the river the biomass decreases and this effect is most pronounced in the Kappersbult on the Drentsche Aa. Low productive vegetation (<400g/m^2), assumed to be most sensitive to nutrient input by flooding, is present most far from the river. The amount of sediment is small and strongly decreases with distance from the river: 2.7 kg/m^2 close to the river and 0-0.07 kg/m^2 far from the river. Absolute amount of deposited clay and organic matter, although being much lower, show a comparable spatial trend. The composition of the topsoil reflects the present sedimentary processes. Nitrogen and phosphate also decreases with distance. Nitrogen input varies between 90 kg/ha close to the river and 5 kg/ha far from the river and must be added to the atmospheric deposition of 30 kg/ha as total input. Phosphate input varies between 45 kg/ha close to the river and 1 kg/ha far from the river.

Keywords: Flooding, grassland vegetation, nutrients, mowing, productivity.

The importance of plant provenance in restoration schemes

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A study investigated the effect of provenance on the establishment of *Lotus corniculatus* at a limestone quarry re-creation site in England. Cuttings were collected from 30 locations in the UK and planted into untreated (bare clay substrate) and treated plots (with topsoil). Comparing all populations, a greater proportion of local plants survived on the treated plots although this was not the case on the untreated plots where other provenances also performed well. There was a relationship between survival and geographical distance on the treated plots and plant size and fecundity on the untreated plots. The effect of ecological distance was only significant for plant size on the untreated plot where plants from more ecologically distant populations were larger and more fecund. A further pilot study investigated the hypothesis that inherent differences between populations of *L. corniculatus* is sufficient to affect the growth rate and fecundity of *Polyommatus icarus* (the common blue butterfly). There were significant differences in larval weight between *P. icarus* reared on *L. corniculatus* from six different locations but no differences in pupal weight or length. Together these studies suggest that plant provenance affects plant establishment and potentially associated herbivores, however, there was no evidence to support the consistent home-site advantage of local genotypes. **Keywords**: local provenance, quarry, restoration, home-site advantage.

Ethical Issues Dividing the Mining Industry and Its Environmentalist Critics: Environmental Ethics Applied to Value Framing in Environmental Conflict Resolution

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There is perhaps no better stage to witness the conflict between environmental concerns and industrial endeavor than that provided by the activities of the mining industry. Environmental disputes relative to mining activities and associated restoration often remain intractable while each side articulates and re-articulates surface issues without an understanding of the moral thinking (values) of each party. The field of environmental ethics can contribute to a better understanding of these opposing values. Frame analysis can be used to extract the values that seed these conflicts. Can this understanding offer improved tools for environmental conflict resolution?

Keywords: restoration, environmental conflict, industry.

Integrated Approach for Ecological Restoration of Water Resources in Ambon City, Eastern Indonesia: *Opportunities and Challenges*

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This study provide overview on the conflict and its effects on deterioration of water resources and water resources management and evaluate challenges and opportunities in adopting integrated approach in the effort of ecological restoration of water resources of Ambon City, a small island city in Eastern Indonesia, after a 3 years sectarian conflict. Factors examined including; 1) current and historical physical condition of water resources and infrastructure (i.e., water quality, water quantity, forest cover and land use, precipitation and temperature, drinking water infrastructures), 2) changes is socio cultural condition of the communities, and 3) current water management framework in the island. Results of the study shows that physical and ecological condition of water resources is decreasing in all respect, except for water quality. There has been great change within socio cultural of the community as the result of the sectarian conflict, and management of water resources need a reform from sectoral approach, to multisectoral integrated approach. Integrated Water Resources Management to local context was recognized as potential opportunities in restoring water resources in Ambon. An alternative water resources management framework that includes community participation as a main factor was developed. Potential challenges for the future was identified along with potential solutions.

Keywords: Integrated Water Resources Management, water resources restoration, water and conflict, Indonesia.

Compensatory measures of Madrid Airport Enlargement

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Due to the enlargement of Madrid Airport with two new runways, it has been necessary to alter the course of the Jarama river in a section of approximately 1,800 m, affecting to the place of communitarian importance (L.I.C.) of Jarama's and Henares basin. The Environment Assesment related to the amplification of Madrid Airport system, dated 13th December 2001, makes it obligatory for AENA to carry out some compensatory measures. This organism entrusted the TALHER & GEOCISA & DDRAGADOS & PROINTEC joint venture the project design and the fulfilment of the correspondent measures which fundamental aim is the restoration and improvement for the recovery of the local natural conditions, as to compensate the ecological impacts produced which affect directly to approximately 1250 ha, and particularly to compensate the damages produced to the L.I.C. These actuations are developed in places that shelter particularly important habitats for the fauna (wetlands, catalogued species breeding areas) included in the Natura 200 Network and particularly in zones C of "degradated areas to regenerate" in the regional park surrounding the low course of the rivers Jarama and Manzanares, as well as reforestation projects included in the Madrid Community Forest Program as erosion ZES 1 and 2 risky zones.

Keywords: basin, erosion, reforestation.

What is soil organic matter recovery worth?

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The conservation and restoration of soil organic matter are often advocated because of the generally beneficial effects on soil attributes for plant growth and crop production. More recently, organic matter has become important as a terrestrial sink and store for C and N to modify greenhouse gas emissions. We have attempted to derive a monetary value of soil organic matter for crop production and storage functions in three contrasting New Zealand soil orders Recent, Melanic and Granular Soils). Soil chemical and physical characteristics of real-life examples of three pairs of matched soils with low and high organic matter contents were used as input data for a pasture production model. The differences in pasture dry matter yields were calculated for three climate scenarios and the yields converted to an equivalent weight and financial value of milk solids. We also estimated the hypothetical value of the C and N sequestrated during the recovery phase of the low organic matter content soils assuming trading with C and N credits. For all three soil orders, and for the three climate scenarios, pasture dry matter yields were decreased in the soils with lower organic matter contents. The decreased yields from the cropped soils were predicted to persist for 36–125 yr, but with declining effect as organic matter gradually recovered, giving an accumulated loss in production worth around NZ$518–1239 ha^{-1}. This was 42 to 73 times lower than the hypothetical value of the organic matter as a sequestering agent for C and N, which varied between NZ$22,963– NZ$80,526 depending on the soil, region, discount rates and values used for carbon and nitrogen credits.

Keywords: soil organic matter, restoration, valuation.

Environmental and biodiversity aspects in seismic and drilling activities in Reggane (Algeria)

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Repsol YPF conducted an environmental impact study (EIS) in the Touat region of the Wilaya of Adrar in Algeria prior to the onset of an exploration program in 2004. A detailed environmental baseline study of the area was followed by an examination, analysis and assessment of the potential impacts of the planned exploration activities. During the baseline study a thorough qualitative ecological survey was conducted to assess the presence of protected or endangered species, known to exist regionally from literature reviews conducted for this purpose. The region is also characterized by a series of communities that have thrived for centuries on artesanal agriculture supported by a *fouggara* irrigation system, an ecosystem classified as a Ramsar site. A combination of safety and environmental concerns for minimizing negative socioeconomic impacts led to early engagement of the local communities within the seismic

survey area, and discussions with community leaders. Mitigation measures were put in place to minimize the impact on flora and fauna and the environment including soils and groundwater. Of particular interest were: the limitation of vehicle tracks during seismic operations (when risk to habitat is greatest due to the extensive travel along profile lines); the implementation of wastewater treatment protocols; and restoration of campsites after the seismic activities were completed.

Keywords: restoration, environmental impact study, Ramsar.

The use of "ecological standard" for assessing the degree of river deterioration in restoration project

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Three sandy lowland river of similar physiografphic and structural characteristics were invetigated. The kazanka (the Middle Volga Region) and the Ems (Northern Germany) manifest morphological degradation and a considerable degree of water contamination. On the contrary, the Jushut (the Middle Volga Region) is an unaltered, a natural river unaffected by man. The indices of water pollution and saprobity characterize the Jushut as oligosaprobic. Biotic diversity is rather high in all the three rivers, and the taxonomical similarity of the rivers´ benthic fauna differs in the range of ten to thirty percent. As a criteria of the ecosystem integrity we tested the metabolic indicators on the meso-sacale: the respiratory activity of the sediment community. We use the Jushut river as a "standard" undisturbed ecosystem. Such a so-called "standard" river would enable us to take into account the modern global anthropogeneic influence. This differs from the common approach with the use or "monitoring" or the past" when the loss of natural biodiversity is evaluated on the basis of historical data. Such a "standard" could be used in restoration projects for rivers with similar climate, geographic and hydrological characteristics.

Keywords: lowland rivers, natural coditions, benthic metabolim, community respiration.

Land Surface Water Cycle Indexes in Semi-Arid Regions of Bulgaria

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The land surface water cycle is critical for natural resources sustainability especially in regions of anomalous water supply. Such a region is the semi arid mountain area in the southern part of Bulgaria located close to the Mediterranean sea. Its climate exhibits long-lasting periods of dry and hot weather conditions influenced by north-African intrusions in summer and sometimes heavy precipitations and flash floods even in winter. Forestry practice attempts for artificial establishment of coniferous in the lower forest belt of this region put some questions about the ecological restoration process. In this paper some water balance indexes are calculated, assuming natural forest environment, both at coniferous and broadleaved altitudinal belts. They are compared with the indexes derived for artificially established coniferous in the oak forest belt. Using the energy balance approach of Budyko, the canopy net radiation and potential evapotranspiration (PET) fluxes, as well as the Budyko's aridity index (AI) are derived on a climatic scale (using a long-term data set for 1961-1990). The results show an average increase in PET of about 123 mm/year and in environmental dryness as revealed by AI growing of about 40%; together these increase the potential for desertification related to land cover change. This implies water shortage strengthening, which is analysed in terms of the responsible functional chain: meteorological environment, growing season, canopy biophysiccs. Knowledge of these changes might have regional environmental and socio-economics consequences by introduction of proper reforestation techniques to combat drought and ecosystems fragility.

Keywords: Land cover**,** artificial forest, potential evapotranspiration, aridity index, sustainability.

Forest Conservation, Restoration and Rehabilitation in parts of Gudem-Saparla Hilly Tracts of Visakhapatnam District, Andhra Pradesh- A RS & GIS Approach

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Forest ecosystem is a complex system having interactions with biotic and abiotic components which includes plant and animal communities along with micro organisms, climate, sunlight water and soil. Slight difference in any of these makes subtle difference in each habitat within an ecosystem. Therefore each parcel of landscape has characteristic soil, moisture and temperature/rainfall regimes which meet the requirement of a given assemblage of plants. Such units are affected because of constant anthropogenic influences leading to severe fragmentation. Hence, these areas need to be prioritized for conservation and restoration in terms of unique habitats and areas of threat. Keeping in view of this, an attempt has been made to prioritize areas of conservation, locate areas to be restored, identify species composition to be rehabilitated in Gudem-Saparla hilly tract covering an area of 325 sq.km in Visakhapatnam district, Andhra Pradesh (India) through satellite RS and GIS techniques. Satellite data of Landsat MSS 1973 and IRS-1D LISS III of 2003 were assessed for forest cover changes in 1 sq.km grid to generate a Sensitive Index (SI) map. Further the road and settlement buffer of 1000m was generated to derive Threat Index (TI) map. The phytosociological data collected at different elevation, slope and aspects in the study area were assessed for stand density, basal area per hectare and biodiversity index based on species richness and Shannon & Weiner index. Through GIS analysis, the areas of higher values of these three parameters, considered to be the best suitable conditions for prioritizing the conservation area representing as Conservation Measure Index (CMI), were delineated. Besides, the distribution of RET species over the study areas to find out the areas to be restored and type of species to be rehabilitated. By integrating SI, TI and RET Index with CMI, the study area was prioritized into conservation areas, also identified areas to be restored and finally the type of species and their composition to be rehabilitated in similar environmental and ecological areas. The study highlighted the usefulness of satellite remote sensing and GIS for decision making and implementation of conservation of high biodiversity areas, restoration and rehabilitation programmes in critical areas of Andhra Pradesh, India.

Keywords: Forest cover change, species richness, threat index, conservation measure index, restoration.

Multi-focal dimensions of Urban Domestic Solid Waste Management

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The economic, social, health and environmental benefits of organizing waste pickers, resulting from the involvement of Pune's citizens and NGOs in domestic solid waste management (SWM) has been studied. The Industrial city of Pune generates over 1200 metric tons of garbage daily, with 25% salvaged by waste pickers. The G R A S P program, initiated by Pune's SNDT Women's University, Continuing & Adult Education Department, redresses various issues -affording dignity of work and enhancing life quality for women of extreme poverty from the marginalized section of the society by adopting a humanitarian approach that also strives to solve their problems as conservationists by formalizing their activity – with the right to access waste as a source of sustainable livelihood, freedom from social exploitation and increased social awareness. This commitment to decentralized, community oriented, labour intensive, sustainable approach to SWM has yet a long way to go, since stakeholders are many; the interests of Nature and waste pickers on one hand, conflicts with that of the vested interest of politicians and municipal workers on the other. However, the study shows that SWM can be made effective by integrating municipal collection of non-recyclables, legitimizing waste pickers' access to recyclables and localizing the composting of biodegrades. This would lead to the restoration of ecology, combined with sustainable development and upward mobility, socially and economically, of waste pickers.

Keywords: Waste pickers, solid waste management, segregation, recycle, biodegrade.

The application of advanced phytoremediation at contaminated soils

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Potential of advanced phytoremediation for restoration of diesel contaminated soils was investigated using pilot scale experiments. Plant-based remediation can have great attractions for remediation and successive restoration of damaged land for future soft ends. Phytoremediation, however, might have some

restrictions because it uses solely naturally driven energy and mechanisms. Therefore, the combination of other techniques can be introduced to overcome these disadvantages and increase the remediation efficiency. In this study, phytoremediation with air injection was applied at artificially diesel contaminated soil. First, to select the appropriate plant species, plant-screening test was conducted by comparing growth rates that were affected by four levels of diesel addition. Second, column and box type studies were conducted using diesel contaminated soil with air injection and alfalfa that showed the strongest resistance against the contaminant and its growth rate was not inhibited by diesel additions. Both the removal efficiency of diesel and the microbial activity were the highest in air-injected alfalfa-planted column soils. It is suggested from the results that air injected phytoremediation system can be used as a supplementary technique at conventional phytoremediation sites. It can also be applied at the sites where bioventing or soil vapor extraction methods had been applied as a final or a complementary treatment for further ecological restoration.

Keywords: Diesel contaminated soils, phytoremediation, air injection, final treatment, ecological restoration.

A New Method on determining bulk hydraulic conductivity of mangrove forest sediment

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Flow of groundwater from mangrove swamp sediment to mangrove creeks is likely to be an important pathway in mangrove swamps, particularly for the removal of salt excluded at the mangrove root. The swamps are generally saturated with water, and are perforated with animal burrows, allowing significant groundwater flow to mangrove creeks to occur. The hydraulic conductivity of the sediment is thus an important physical parameter but is very difficult to measure *in-situ*. In this work it will describe a simple method for determining the hydraulic conductivity of mangrove sediment, including the effect of macropores such as crab burrows, that uses the existing animal burrows as piezometers. Experiments to measure the hydraulic conductivity of the sediment were carried out in a variety of mangrove forests. It was found that hydraulic conductivity varied from around 1 m/day to 10 m/day, which is at least10 times greater than would be expected if there were no burrows.In order to check the validity of the method, conventional piezometers were used to determine the free water table level in an area of mangroves fringing a creek. From these measurements, hydraulic conductivity was determined independently and found to be consistent with the new methodology.

Keywords: hydraulic conductivity, mangroves, burrow, piezometer.

From revegetation to restoration practices: an example from Iceland

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Iceland, a volcanic island located on the mid Atlantic ridge has experienced serious degradation and desertification during its 1100 years of human settlement. There has been an organised reclamation work in Iceland since 1907 when the Soil Conservation Service was established. Initially, the focus was on halting erosion. With improved techniques in agronomy mid last century the focus shifted towards revegetation practices, i.e. the emphasis was on creating vegetation cover as fast as possible without much concern for what kind of vegetation developed. Sown grasses and fertilisation became the main method, mostly using introduced species. In the 1990s, the general approach changed with more emphasis on ecological processes and restoring functional ecosystems. At present reclamation is mainly viewed as a manipulation of succession. Given the extensive badly degraded areas in Iceland the work often deals with primary succession. This paper summarises the change from agronomic to ecological approach in reclamation and presents studies of succession using different approaches. They include a study of primary succession in an area with no reclamation work, an extensive experiment with different reclamation inputs comparing impacts of different treatments on processes and functions of an ecosystem, and chronosequence studies with comparisons of old reclamation sites with different history. The results show that reclamation methods may determine the trajectories of succession, and that poorly functional ecosystem can be restored to a well functional ecosystem although compositional different to what was likely to be originally.

Keywords: Iceland, reclamation, succession, volcanic soil.

The struggle for cockles. Boundary work and contextualisation in the controversy on cockle fishing in the Dutch Wadden Sea. Lessons for restoration

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Ecological restoration is the process of assisting the recovery of ecosystems that have been degraded, damaged, or destroyed. Because of this objective restoration may be characterised as a value and interest laden activity in which scientific and societal purposes are interwoven. The mélange of practical, scientific and societal aspects as a general phenomenon in nowadays society is called mode 2 science can be distinguished from mode 1 science. The latter is related to the classical view of 'pure', curiosity-driven, fundamental, or autonomous science, detached from society, and often disciplinary organised, whereas mode 2 knowledge production is much stronger societal contextualised. Contextualisation implies application-oriented research, trans-disciplinary cooperation, multiple accountabilities, and extended (society related) quality assessment procedures. Contextualisation requires boundary work, i.e. the process of determining of what counts as scientific and non-scientific is constructed and negotiated. We studied the process of contextualisation and boundary work in the long controversy on the effects of cockle fishing in the Dutch Wadden Sea in which ecologists, nature protection organisations, and fishermen organisations were strongly involved. We conclude that boundary work requires an open platform of science and that so-called 'boundary rules' are required to facilitate a social robust form of knowledge production. In our view, the responsibility of the scientist is not only to provide data and ecological arguments, but also to evaluate, deliberate and to communicate the use of the scientific results an insights in the decision-making process to the wider audience. We will apply these insights to the role of expertise in restoration projects.

Keywords: mode 2 science, boundary work, contextualisation, controversy, cockle fishing.

Botanical and faunistic research in Dutch road verges as a support for ecological restoration

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About 68% of the Netherlands is used for agriculture. Only a small part consists of nature reserves. Consequently many plant communities and species are endangered. The agricultural landscape is crisscrossed by a network of linear elements like road verges. Here species from semi-natural plant communities can find refuges. In Dutch road verges 69 plant communities were distinguished comprising 50% of the Dutch flora. Besides 123 mosses and lichens have been registered. Of the higher plant species found in road verges about 17% is rare to rather rare in the Netherlands, 59% is less common to common, while 24 % is very or extremely common. In different landscapes some species are more frequent or occur exclusively in road verges. The importance of road verges for invertebrates could be demonstrated. The relation between plant communities and the occurrence of invertebrates is apparent. Plant communities prove to better indicate the presence of the animal groups studied than a combination of the environmental variables and vegetation structure. Different plant communities have a different importance for different groups of animals.

For most, common Ground Beetles, Spiders and Weevils road verges are suitable hibernation sites. In general it can be concluded that in the agro-industrial landscape, the extra contribution of verges to the conservation of the floristic and faunistic diversity is considerable and that the ecological importance can strongly increase when properly constructed and managed. Plant communities can very well be used as a tool for directing the ecological management of invertebrates.

Keywords: invertebrates, diversity, vegetation, management, construction.

Explaining poor health of rehabilitated eucalypt forests following bauxite mining in south-western Australia

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Rehabilitation of jarrah (*Eucalyptus marginata*) forests following bauxite mining is largely successful at rapidly re-establishing vegetation in the high rainfall region (>1200 mm) of south-western Australia. However, in some areas, growth rates decline and mortality increases several years after establishment. Study sites

classified as unhealthy have approximately half the number of trees per hectare; and their trees are 40% shorter and have 30% less girth than trees on adjacent healthy sites. This study aims to diagnose causes of poor health by examining seasonal changes in above-ground physiology and below-ground morphology of 13-year-old rehabilitated jarrah and marri (*Corymbia calophylla*) trees. Jarrah physiology data from 2003/04 and 2004/05 summers show trees on unhealthy sites reached more negative midday leaf water potentials (-3.5 MPa) than trees on healthy sites (-2.7 MPa). Trees on unhealthy sites also had lower midday stomatal conductance (55 mmol m^{-2} s^{-1}) compared to trees on healthy sites (176 mmol m^{-2} s^{-1}). Following break-of-season autumn rain, midday leaf water potentials on unhealthy sites increased to -1.5 MPa, while remaining relatively low on healthy sites (-2.1 MPa). Midday stomatal conductance rates responded similarly. These seasonal trends along with recent root and soil studies indicate that unhealthy sites have shallow and compacted soil profiles that restrict roots to upper horizons. Trees growing on healthy sites with deeper soils have access to more stored soil moisture over summer, however, once depleted this larger soil volume re-wets slower than shallower soils of unhealthy sites. Studying the response of vegetation to the new soil conditions of the post-mining landscape is essential to improving the sustainability of rehabilitated forests.

Keywords: *Eucalyptus marginata* (jarrah), rehabilitated bauxite mines, tree physiology, water stress, root distribution.

Creation of suitable birds habitats in a project of environmental restoration of miner industry

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The mining restoration of the lignite deposit in Northwestern Spain demands the filling of the excavation hole with water in order to create an artificial lake which flows into the basin of Eume river. Among the restoration actions of the lake ecosystem, the creation of suitable habitats for vertebrates, specially destined to birds is proposed. The E.I.A. includes an environmental monitoring plan. As special measures we plan the implementation of an ornithological island in the west of the lake of 8.5 ha with suitable relief and vegetation. This would facilitate the internal pool formation and the diversification of wet lands environments. The final section of Illade river will have a restricted access area in order to limit the anthropic disturbances for nesting birds. Lake's drainage channel will be adapted for fish fauna development. Other infrastructures of the mine such as the water derivation tunnels, will be transformed in bats refuges. The management actions contemplates the selection and installation of birds observatories, increasing the educative and scientific value of the lake ecosystem.

Keywords: mines, restoration, birds, ornithological island.

Restoration of urban streams, application of a Stochastic-dynamic methodology (SDM)

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The main environmental problems of river and stream degradation are found around urban areas, namely due to domestic and industrial effluent discharges, dump deposition, uncontrolled constructions within the flood riverbed and riparian gallery destruction, with immediate consequences on the riverine ecosystem. This study is a characterisation of five streams (two in "Macedo de Cavaleiros", one in "Maia" and other two in "Gaia" municipalities). The latter research was based on physicochemical and microbiological parameters, as well as on vegetation biovariability studies, soil occupation, hydrologic and cartographic data. A stochastic-dynamic model was then developed as a decision supporting tool, directed mainly to water resource managers, enabling the assessment of water quality based on benthic community biovariability measurements. According to our results the best solutions, to attain stabilisation of the riverine banks and improve water quality, should use vegetation followed by rock in order of relevance. Rehabilitation solutions using concrete should only be used as a last resource. Moreover, for several tested scenarios, the studies on benthic community biovariability reflected the importance of effluent treatment and also responded well as indicators of environmental changes.

Keywords: Forest, urban streams, restoration, ecosystems.

Making the link between restoration ecology, biodiversity experiments and assembly models

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In restoration projects practitioners strive to restore a whole range of different ecosystems, from locally highly disturbed sites after mining to the improvement of degraded agricultural land. These different sites do have some things in common, however. In all systems there is a flow of energy and matter, a constant transformation from inorganic into organic matter and vice versa. The effect of the biota on geochemical cycling, known as biogeochemistry, is an important issue investigated in biodiversity and ecosystem functioning (BD-EF) experiments. Applying this perspective to restoration activities, means that all ecosystems in a modern landscape are seen as biogeochemical systems anywhere along a continuum: from a balanced relationship between biodiversity and ecosystem functioning to a misfunctioning relationship. One main goal of restoration could therefore be to restore the system back to a functioning relationship between biodiversity and ecosystem functioning. In future we need to compare results of grassland biodiversity experiments with data from natural grasslands, and test how robust any relationships found are under different environmental conditions. In particular the high productivity found in biodiversity experiments is attributed to certain plant species mixtures, and in nature such mixtures may never occur in such constellations due to assembly trajectories affacting which species can establish themselves. We need to test how useful specific ideal mixtures of species could be in restoring ecosystem functioning in restoration projects.

Keywords: restoration, ecosystem functioning, ecological theory, biodiversity experiments, functional diversity.

Non-market valuation of best management practices for stream corridor restoration

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Excess storm-water runoff from an impervious surface results in stream degradation, habitat alteration, low base flows and increased toxic loading from non-point sources. An important component of stream restoration is the implementation of best management practices (BMPs) that reduce effective impervious area. BMPs include structural options such as bioretention facilities (e.g. rain gardens) and non-structural options such as urban forestry, i.e. the preservation and planting of urban trees. BMPs affect the landscape in both positive and negative ways that should be accounted for when evaluating the net benefits of a stormwater management plan. This paper will compare the total net benefits of achieving a given stormwater runoff reduction through two alternative strategies, residential bioretention auctions and urban forestry. Non-market economic valuation techniques will be used to measure costs and benefits that go beyond construction costs. The effect of residential bioretention facilities on homeowners will be measured through an auction being conduced as a U.S. EPA pilot project. Homeowners will reveal their "willingness to accept" by bidding on compensation to be received in exchange for allowing the installation of bioretention facilities in their yards. Additional benefits of urban forestry will be measured with a hedonic model that measures the differing value of houses based on proximity to street-side trees.

Keywords: Stormwater management, Pollution control, Urban stream restoration, Urban forestry, Non-market valuation.

Ecological processes leading to community assemblage in roadside plants: filling the gaps in the restoration of motorway slopes in Mediterranean climates

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Roadside plant communities are the core of an emergent ecosystem rapidly expanding over the planet. In these roadsides, native and introduced species lead to communities of poorly known structure and function. Competitive exclusion and environmental structuring processes have different relative importance under different environmental conditions and the phylogenetic structure of the community is crucial to disentangle the contribution of these processes in the assemblage of the community. We wanted to unveil

the dominant ecological processes leading to plant community assemblage under different environmental conditions, which is a requisite for the effective restoration of roadside ecosystems. Twenty nine morphological, architectural and reproductive traits were determined together with the phylogeny of the 386 species recorded in 41 motorway slopes. The slopes were distributed in two categories –embankments (favourable soil and inclination) and roadcuts (poor, rocky and steep surfaces)- and in two contrasting localities in Mediterranean Spain -Málaga (mild and humid) and Valencia (dry and continental)-. By the exploration of the phylogenetic signal in each functional trait, the number of traits with positive and negative phylogenetic signal and the importance of syndromes or correlated traits in each locality and type of slope, we concluded that there is not a common ecological process structuring roadside plant communities. While habitat filtering, evidenced by phenotypic attraction, predominated under adverse conditions (Valencia), competitive exclusion, evidenced by phenotypic repulsion, predominated in more favourable environments (Malaga). Thus, phenotypically diverse taxa should be used in revegetation under favourable conditions, while the reverse is true under adverse conditions.

Keywords: environmental conditions, functional trait, phylogenetic signal roadside plant communities.

Use of Millennium Seed Bank Project Collections in Restoration

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The International Programme of the Millennium Seed Bank Project, which runs from 2001 to 2010, aims to develop a worldwide seed conservation network, capable of safeguarding targeted wild plant species and contributing to global conservation goals. A key conservation objective is the use of *ex situ* collections for recovery and restoration programmes, as required under Target 8 of the Global Strategy for Plant Conservation. An emphasis on large, high viability seed collections with comprehensive field and germination data, together with accurately identified herbarium vouchers is providing a secure foundation for such future uses. The MSB Project expects to collect and conserve seed from 24,200 wild plant species. It is currently working with partner organisations in 17 different countries. Seed collections are stored in the country of origin, with duplicate collections stored at the Millennium Seed Bank itself, in the UK. The aims of individual partnership projects vary, but several have established links to restoration and re-introduction activities. These often involve further partnerships with organisations including mining companies, botanic gardens, and local voluntary and statutory conservation groups. Examples are presented from MSBP partnerships in Australia, USA, Chile, South Africa and Madagascar. Consideration is given to the respective skills, knowledge and other strengths and roles of the Millennium Seed Bank, partner seed banks and other partners.

Keywords Seed bank, partnerships, international.

The Priolo project: the last chance to save the species?

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The Azores Bullfinch (*Pyrrhula murina*), or Priolo, is a globally threatened species, with about 200 individuals surviving strictly in an area of 6,000 hectares in the island of São Miguel, Azores. A LIFE project is under way in order to save the Priolo from extinction by restoring 300 ha of natural laurel forest in the main distribution area. The main objectives are: to secure a stable population through the implementation of long-term habitat management actions; to secure the legal protection of the species; to secure the continuity and sustainability of the measures through a management plan involving all the local stakeholders. Concrete habitat management actions are being carried out to improve the habitat for the Priolo, involving the clearance of exotic invasive plant species and the planting of native species that provide food to the birds, as well as creating fruit tree orchards to improve food availability in the end of the winter (one of the limiting factors). Most of the actions consist in recurring habitat management actions .We also tested and implemented chemical methods to control the exotic plants. This ambitious and complex project is, probably, our last chance to save this highly threatened bird species.

Keywords: Priolo, Laurel forest, habitat management, chemical control.

Wetland Resources and Livelihood of Local Ethnic Communities *(A Case Study from Beesh Hazar Tal, Chitwan, Ramsar Site of Nepal)*

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The study was designed to document the wetland resources, their intensity of utilization, and identify management responsibilities of stakeholders. Household questionnaire survey, focused group discussions, and wetland resources sampling techniques were performed. Four clusters of ethnic communities (Two clusters of Tharu community, Darai and Musahar community) were identified as actual stakeholders on the basis of proximity, accessibility and frequency of visit to the lake. 75 wetland plant species were documented. 37 plant species were used as vegetables; 4 species used as spices and pickle; 26 species used for medicinal purposes; 13 species used to make mats, fibers, etc. 13 species of fishes and one species of snails, preferred resources by Tharu and Darai people were also available. Wetland resources were easy option to fulfill the household demand mainly in off farm season. It was concluded that restriction on human activities was detrimental to natural system of the lake and to local people. If managed through local initiatives, the lake possesses high potentiality of wise use to enhance socioeconomic status of local ethnic communities.

Keywords: Ethnic communities, livelihood, stakeholders, wetland, wetland resources.

Studies on Soil Degradation and Its Restoration in Hilly Area of Lancang River Upstream, Yunnan China

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Eight normal soil utilization types in hilly area of Lancang River upstream, Yunnan China were selected to study the soil deterioration and restoration with in-situ method. There were significantly differences among soil utilization types within SOM, TN, available N, P, K, and $NH_4^{£´}$–N and $NO_3^{£≠}$–N but no much differences in vertical spatial variation within 0~40cm soil layers for each type. The soil nutrients of all soil utilization types for secondary forests and planted economic forests, and cropland even abandoned land were declined. Comparison with nature broadleaved forest, SOM reduced 70.89% in slop cropland, 76.8% in eucalyptus forest and 73.14% in pine coniferous forest, and TN reduced 76.4%, 88.76% and 85.39% for slop cropland, eucalyptus forest and pine coniferous forest respectively. Soil available nutrients have same declining trends, especially available P and N declined to 2~10 times. The deterioration index of slop cropland, pine coniferous forest and abandoned land was higher than –0.6% indicating their soils are degrading seriously. The deterioration index of mixed forest was highest among all soil utilization types, which indicated the type might be as a model for restoration degraded soil ecosystem in mountainous area of Lancang River upstream.

Keywords: Soil utilization types, Lancang River upstream, soil nutrients declining, deterioration index, model of restoration.

Reducing available soil nitrogen by amendment with organic carbon sources to promote restoration of natural grassland on abandoned agricultural fields

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Re-establishment of native grassland on abandoned agricultural fields is sometimes retarded by the legacy of high nutrient concentrations, the reduction of which facilitates the succession towards the native grassland. In these studies we have added different amounts of simple and complex organic carbon sources (sucrose and sawdust, respectively) to soils from abandoned fields on sandy soils from the Great Hungarian Plain (Kiskunság National Park). Using laboratory investigations we have established the optimum C addition to immobilise the maximum about of available soil N. We have monitored the soil microbial response to C addition by respiration and the assimilation of soil N by both inorganic N and microbial biomass measurements. From these experiments we have also been able to determine the rate of response. These laboratory experiments complement field-based studies conducted by Szili-Kovács *et al.*

Keywords: Soil N availability, N immobilisation, microbial biomass, C addition, restoration.

Defining restoration targets and strategies for peatlands in NE-Germany

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In Germany around 95% of the peatland area (ca. 13.500 km^2) have been drained for agriculture, peat mining, or forestry. Due to increasing drainage costs, land use changes, and growing environmental awareness these use forms cease and peatland restoration is becoming increasingly important. Most restoration projects aim to restore a plenty of „functions" as high biodiversity, target species, a pure environment, wilderness, beauty, peat formation, or traditional cultural landscapes. As demonstrated with exemplary projects from NE-Germany it is evident after a decade of large scale peatland restoration that some restoration targets are incompatible, unrealistic or difficult to proof. The reasons are (1) lack of knowledge on natural potentials and risks, (2) loose or inconsistent concepts of conservation targets and priorities (e. g. wilderness, target species, beauty), (3) resistance of local people and (4) missing or inadequate monitoring. To minimize these shortcomings and to improve future restoration success it is proposed: (1, 4) to elaborate national as well as regional peatland inventories and decision support systems, to analyse the ecohydrology of each peatland ecosystem designed for restoration and to intensify monitoring as well as research on ecosystem processes following restoration measures, (2) to advance the conceptional coherence and local adjustment of targets, and (3) to achieve acceptance due to sufficient involvement of the public at all stages of planning. Finally three basic strategies of peatland restoration are presented each combining a specific priority of restoration targets and sets of restoration measures.

Keywords: peatland restoration, restoration planning, restoration strategy.

The effect of prescribed burning and decaying wood on the diversity of beetles

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Forest fires are one of the most important disturbances of boreal coniferous forests. Today, natural fires have become rare due to effective fire suppression and the diversity of species associated with burnt forests has decreased. Another limiting resource for forest species is the availability of decaying wood. In Finland, at least 4 000 species are classified saproxylic (dependent on dead wood). The aim of our research is to study the effects of prescribed burning and the importance of the quality and quantity of decaying wood on the diversity of beetle fauna. We conducted a burning experiment at Evo, Southern Finland, where we selected 24 spruce-dominated forest plots. 18 of these plots were harvested and different quantities of decaying wood were formed. Half of the study plots were burnt in summer 2002. We monitored the beetle diversity during the subsequent years by sampling beetles with window traps. In addition, we studied the beetle fauna of old silvicultural burnings and clearcut areas of the corresponding age. Our results show that beetle diversity is higher at burnt plots than at unburnt study areas. Burning has also a positive effect on the abundance of saproxylic beetles and on the occurrence of rare beetle species. Harvested study plots with increased amount of decaying wood had higher diversity than unharvested control plots. Also the old silvicultural burnings harbour more diverse beetle fauna than the corresponding clearcuts. We conclude that prescribed burning can be used as an effective tool in restoring species diversity in boreal forests.

Keywords: saproxylic beetles, wood, diversity.

Restoration of boreal forests and mires in the EU LIFE-Nature project 'GreenBelt' in northeastern Finland

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Fennoscandian Green Belt is an extensive area of unspoilt natural forests, mires and arctic fells at the border between Finland, Russia and Norway. At the proteced areas of the Finnish side, however, the forests are partially affected by former commercial forestry and mires have been partially drained. The EU LIFE-Nature project 'Natural forests and mires in the Green Belt of Koillismaa and Kainuu' (GreenBelt) aims to improve the state of 13 protected areas at the Finnish side of the Fennoscandian Green Belt. The restoration work will begin in summer 2005. Natural succession will be generated in the forests by controlled burnings, simulations of storm damage, damaging and felling trees and by reforesting disused forest roads. Mires will be restored by damming or blocking ditches and by removing trees. Monitoring and research will involve the comparison of various restoration methods in terms of their ecological success and cost-efficiency. The scale of impacts of restoration will be investigated by using e.g. spatial modelling methods. Information obtained from the network will be used for the development towards

more practicable and cost efficient restoration methods. Since established populations of species associated with decaying wood and burnt forests live just over the Russian border, it can be assumed that these species will spread into Finland when suitable habitats have been restored. The first summer of restoration work and research will be presented.

Keywords: Boreal forests, Burning, Forest restoration, Mire restoration, Succession.

Restoration of raised bogs: biogeochemical processes involved in the re-establishment of *Sphagnum*-dominated vegetation

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Restoration of bog remnants by hydrological measures generally leads to inundation and rapid development of *Sphagnum* vegetation when poorly humified peat is still present. The peat either swells up or becomes buoyant, creating a favourable substratum for *Sphagnum*. In many cases, however, only strongly humified peat is remaining and *Sphagnum* redevelopment is usually not observed. Waterlogging of peat remnants is therefore preferred in this case. Bulk density, peat structure and methane production all play an important role in the buoyancy of floating peat and newly formed *Sphagnum* carpets. Methane appears to provide peat buoyancy. Peat characteristics such as C/P and lignin/P ratios, and pH, determine decomposition rates and hence methane and carbon dioxide production. On locations where only strongly humified peat is present, floating raft formation can be stimulated by the introduction of peat with suitable characteristics. Methane production rates in acidic substrates can be enhanced by mixing the peat with small amounts of lime. Substrate derived carbon dioxide and methane both appear to serve as an important carbon source for *Sphagnum.* High carbon dioxide concentrations in the acrotelm strongly stimulate hummock formation by *Sphagnum magellanicum.* Typical hummock species are, however, usually very slow colonisers. Introduction of these species in carpets dominated by *Sphagnum cuspidatum* or *Sphagnum fallax,* or on bare peat, appears to be very promising. The results show that biogeochemical and ecophysiological knowledge is vital for the choice of sound bog restoration strategies.

Keywords: Bog restoration, carbon dioxide, methane, peat buoyancy, *Sphagnum.*

A comparative analysis of the vegetation, seed bank and environmental conditions of abandoned limestone quarry floors and alvars in Southern Ontario, Canada

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Quarrying can alter or remove communities of native plants, but restoration ecology offers tools to repair this damage. Very little rehabilitation has been carried out in abandoned quarries in Ontario, Canada, despite legislation that requires extraction companies to restore the land. The goal of this research is to explore alvars as a possible restoration target for abandoned limestone quarry floors. Alvars are natural limestone pavements with patches of thin, alkaline soils and vegetation that is adapted to extreme environmental conditions such as flooding and drought. In order to determine the ecological differences between alvars and quarry floors, we conducted vascular and non-vascular vegetation surveys in twenty-five quadrats at each of thirteen quarry sites across southern Ontario. We also conducted seed bank analyses and measured soil cover, soil depth, soil nutrient concentrations, and ground-surface temperatures. These data were compared with those previously collected on southern Ontario alvars. We found a high similarity of environmental conditions and a high proportion of overlap in the vegetation communities of the two ecosystems, including the discovery of alvar endemics growing on quarry floors. The quarry seed bank was highly representative of the above-ground vegetation, suggesting that alvar species on quarry floors may have seed input as a limiting factor. These results indicate that an alvar could be a possible reference system for the restoration of abandoned limestone quarry floors, and rehabilitation guidelines could be developed for extraction companies.

Keywords: alvar, quarry floor, restoration, community composition, seed bank.

Using succession as teacher: Species selection for road embankments revegetation

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The objective of this study is to develop a protocol of species selection for revegetation of road embankments in semiarid environments. Protocol consists of three successive stages: (1) survey of spontaneous colonizing flora to determine what species colonize successfully road embankments, (2) manual sowing experiments to test the suitability of selected species in point 1, (3) hydroseeding experiments with public works methods to compare revegetation success of selected species in relation to widespread commercial species and to test top soil addition. Vegetation surveys proved to be a useful tool to identify spontaneous colonizing species to be used in revegetation. The results obtained after manual and hydroseeding sowing experiments confirmed the success of the selected species in road slope revegetation. Three months after hydroseeding, when erosion risk are high, total vegetation cover was significantly higher for selected species treatment (38%) than commercial species treatment (23%). One year after sowing the same trends remained and results indicated that species selected in surveys performed better than commercial ones. Moreover, experiments indicate that adding properly managed topsoil may be an alternative to expensive hydroseeding treatments.

Keywords: hydroseeding, revegetation, road embankment, semiarid, species selection.

Regeneration of vegetation after tourism impacts in protected areas in northern Finland

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Tourism is one of the fastest growing industries globally, and within tourism, nature-based tourism is considered to be the greatest growing form. Tourism is mainly concentrated to conservation areas. The effects of tourism are diverse: ecologically tourism causes pressure on natural communities, socially it affects to local residents' life and economically it has effects to areas welfare. We have monitoring and experimental studies to investigate the effects of recreation activities to nature. Our results of ecological studies show that plant responses to trampling varies in terms of life form and morphology. Reduction in density and cover of vascular plants occur quickly at relatively low trampling intensities, but as either the intensity or the frequency of trampling rises the rate of deteoration becomes much slower. The influence of contrasting recreation activities may differ considerably due to e.g. the differences in the mechanical impacts on soil and vegetation. An risk for the biodiversity of protected areas is caused by invasive species, which, once introduced, may spread along trails and occupy space from local species. Our results show influence by horses on the species composition: seedlings of fast-growing grasses and forbs emerge along trails and horse resting areas. Our research provided information on the ecological sustainability of nature tourism can be used in developing ecological principles for the management of protected areas, for trail network planning, and for the restoration of severely damaged habitats in northern Finland.

Keywords: Regeneration, vegetation, tourism, protected areas.

LTER plant population studies at reference habitats help to improve restoration tools: a case study from Hungary

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The study of ecosystem dynamics and the impact of environmental variability in space and time has been a common aim in the goal setting of LTER research topics. The dynamics of community constituent plant species that provide the structure of the community is of major importance for restoration planning. As such, the dominant species of the endemic sandy grassland community (*Festucetum vaginatae*) have been studied at the Kiskun LTER site, Hungary. This community is adapted to drought conditions, however, extreme dry years may cause a major dieback of grass species. Therefore, regeneration from seeds is crucial for the long-term persistance of this community. Seedling dynamics has been studied for the two dominant grass species, *Festuca vaginata* and *Stipa borysthenica*, by field survey and manipulations at natural sites over 6 years. Field experiments on seed burial have revealed that *Stipa* emerges predomi-

nantly from the lower soil layer (2-10 cm), while *Festuca* from the upper 0-2 cm. Seedling emergence and survival rates varied greatly among years, with both species showing complete seedling mortality in extreme drought years. This sensitivity greatly influences, sometimes threatens the result of restoration efforts. This was the case for the sandy grassland restoration experiment at abandoned arable fields in the Kiskunság. Seeding design followed the results of LTER research, but the extreme drought of 2003 killed all *Stipa* seedlings. This way, *Stipa* had to be reseeded. For *Festuca* the dieback was not complete, and the remaining seedlings have reached regenerative stage already by 2004.

Keywords: drought, regeneration, sandy grassland, seedling survival.

New water management strategies for lake Volkerak-Zoommeer

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Lake Volkerak-Zoommeer was created in 1987 as part of the Deltaworks. Although the Deltaworks increased safety against flooding, the endikements have had marked effects on the development of the ecosystem. Lake Volkerak-Zoommeer was transformed from an estuarine area into a freshwater lake. The most important problem for the sustainable development of lake Volkerak-Zoommeer is eutrophication resulting in persistent large-scale blooms of toxic blue green algae.

In 2000 a study was started to identify sustainable solutions for the existing problems, anticipating on future developments resulting from climatic change. The challenge was to design 'tailor-made' solutions on the level of the catchment area. For this purpose an integrated planning approach was adopted, involving all relevant actors in the design process. Several water management strategies were identified and confronted with the most important user functions and spatial relationships within the study area. Ultimately eight possible final states for lake Volkerak-Zoommeer were described. To translate the complex problem, a roadmap for the long-term development of the Volkerak-Zoommeer was created. This roadmap presents the possible 'pathways' and necessary measures to reach the final states, in a transparent and relatively simple manner. Eventually, by using the roadmap two water management strategies were selected for further evaluation in an environmental impact assessment. Thus by using an integrated spatial approach and participative design methods, several objectives could be achieved simultaneously. As amongst other aspects, water quality, safety and ecological restoration are all integrated in the water management strategies that were developed.

Keywords: eutrophication, integrated planning, public participation, restoration, water management.

Beyond the Growth Illusion: Successful Irrigation Communities as Sustainable Ecosystems Built around the Scarcity of Real Wealth and Acceptance of Thermodynamic Reality

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The concept of restoring ecosystems and their vital functions encompasses the restoration of sustainable man-made production systems, which are now known to exist widely throughout the world rather than being extremely rare as they were once thought to be. This paper argues, based on extensive comparative research on successful farmer-operated irrigation systems, that such cases of effective local governance of a common-property resource have a great deal more in common than has generally been recognized. They form a single well-defined type of community based on the principles of equity and transparency in water use. The systems reveal that people are quite capable working out enforceable agreements for mutual self-restraint and for cutting back on their consumption of vital resources, provided that the challenge is framed in the proper way. These self-organized and self-operated human ecosystems are predicated on the reality of scarcity and the necessity of having to make the best of a bad situation and share one of the most basic forms of natural capital or 'wealth'. At the most basic level, the axiom around which the systems are constructed is that such 'wealth' is not created by humans but finite, unpredictable, and subject to degradation through its use or transfer from one person to another. The author argues that these local economies are successful, sustainable, and of great theoretical importance precisely because they are "beyond growth", being based on thermodynamic reality rather than on the prevailing capitalist illusion that "wealth" is potentially infinite and somehow created by humans.

Keywords: man-made or cultural ecosystems, water, irrigation, sustainability, thermodynamics.

Evaluation of the implementation of a goal-oriented peatland restoration plan

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Ecological restoration is a problem driven scientific discipline. Thus from time to time an evaluation of the restoration strategies is needed to further improve the concepts. In Northern Germany, a peatland restoration plan was adopted by the Environmental Ministry in 2002 with the goal to (I) rehabilitate the water quality improvement potential of degraded peatlands and to (II) create suitable habitat conditions for endangered wetland species. The implementation of this plan follows a staged concept. The goals are clearly stated in the plan. For state-wide site selection, a GIS-based peatland information system was developed. For each peatland, information about land use, hydrology, conservation status, species occurrence and soil data are stored in the database. Most effective peatland sites are identified by calculating a land use intensity index. A flow path-oriented decision support system was developed to calculate the effect of land use and water management changes on nitrogen outflow and nitrogen transformation. The model result – reduction of nitrogen outflow – is transformed into a cost-effectiveness value, which is used to rank the funding proposals. The DSS is developed as a user-friendly, web-based software; it's handling requires basic knowledge of landscape hydrology. However, local authorities does not use both tools intensively. For them, the most important factor for site selection is the possibility of land acquisition. To improve goal-oriented site selection and planing, local authorities need more training and a better hydrological understanding. To improve the effectiveness of ecological restoration projects, training and capacity building are equally important as tool development and research.

Keywords: Decision support systems, Germany, planing, site selection, wetland.

Native vs Exotic: cultural discourses about flora, fauna and belonging in Australia

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Environmental debates about which plant and animal species 'belong' in particular locations have a growing significance around the world. We argue that ideas about which species constitute weeds or pests and how those species should be managed can be strongly grounded in cultural values and beliefs. Such beliefs are often linked, directly and indirectly, to everyday assumptions about national, regional, local and personal identities. Strong emotional attachments to particular species or landscapes can shape individual and community responses to flora and fauna with implications for issues of sustainable development and planning. This paper focuses on beliefs and practices that are thereby of relevance to urban environmental management. The study setting is the city of Perth, Western Australia. We aim to better understand the connections between nature and culture in a settler-descendant society, focusing on contesting views about 'indigeneity' and 'belonging', in both social and environmental contexts. Sense of place, the notion of a hybrid cultural and environmental heritage, scientifically informed beliefs about environmentally appropriate practices, and contesting aesthetic preferences are key themes in this discussion.

Keywords*:* cultural landscapes, feelings of attachment, nature & belonging, native & exotic species, culture & identity.

Scientific and social expertise required for extensive restoration of lower Danube river wetlands (Romania)

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The paper is intended to discuss on major arguments for extensive ecological restoration in the former floodplain which was converted into intensive agricultural land (more than 80 percent from the total surface of over half million of hectares) between 1970-1990 and on major related social and economic impact. The need for combining the scientific background with accurate information, effective tools and skills derived from holistic social and economic analysis, proved to be the most critical step in the implementation of so called "Green Corridor of Danube River" international project. The content of the paper will be focused on some constraints, procedures and achievements regarding decision making and implementation in this particular case.

Keywords: ecological restoration, floodplain, Danube River.

Restoring vegetation resilience in fire-prone Mediterranean shrublands

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The lost of keystones species is critical to ecosystem structure and functioning. In large areas of the Mediterranean Basin, land use and disturbances have changed landscape to early succesional stages of the vegetation, dominated by seeder species with high fuel accumulation and a reduced response after disturbances. One aim of the restoration of these areas is to increase formations with resprouter species to improve the ecosystem resilience. The reforestation of Mediterranean degraded lands with broadleaved and late-successional species usually releases low survival rates. Clearing the vegetation generates a slash layer that protects the soil from erosion, while preserving desired species. We aimed to assess the effectiveness of vegetation clearing and mulching on the reintroduction of *Quercus ilex*, *Rhamnus alaternus* and *Pistacia lentiscus* in fire-prone Mediterranean shrublands. The clearing treatment *a priori* improved environmental conditions of the planting holes in comparison to those within the shrubland. Species responded in a different way to site preparation: mastic tree showed higher survival in the cleared plots and after mulch application. Seedlings of the three species grew more after clearing than within the shrubland. A significant site preparation-time interaction was observed due to the improved growth within the shrubland in the first months while clearing resulted in a higher final size. Unexpectedly, the application of mulch had a negative effect on seedling growth of *Quercus* and *Rhamnus*. We conclude that combining clearing with planting for the appropriate species for the sites is recommended to reduce fire hazard, to slow fuel load buildup, and to increase ecosystem resilience.

Keywords: resilience, reforestation, *Pistacia lentiscus.*

Paleolimnology and Long-Term Series: how can we use them in Restoration?

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During the last decades, government agencies have tried to implement plans for lake and watershed management and restoration efforts in numerous Spanish sites. In most cases, little was known of the lake dynamics and the previous history of the system, and consequently neither the “pristine” stage to be preserved nor the results of the conservation efforts can be easily evaluated. Even in the very few sites where long-term series of ecological data are available, they only span a few decades, making difficult to discern between changes due to human influences from those within the natural variability of aquatic ecosystems. Successful restoration efforts need longer records of the natural variability and the response of the lake system to past global changes. We describe two case studies of management policies in two Spanish lakes: Zoñar (Guadalquivir River Basin) and Chiprana (Ebro River Basin) with a long history of human impact in the watersheds. The study of the sedimentary record using paleolimnological techniques, and the available monitoring data provides an efficient strategy to: i) understand the hydrological, limnological and ecological dynamics of the lake systems, ii) identify the main drivers and pressures over the sites to be restored, and iii) establish targets to be achieved in management plans to restore those natural conditions. Paleolimnological studies provide an opportunity to better understand the interaction between humans and the environment against a background of climate variability, and help to define conservation policies in Mediterranean wetlands and lakes.

Keywords: paleolimnology, lakes, restoration, long-term ecological research sites, Mediterranean.

Long-term evaluation of restoration projects in the Mediterranean. The REACTION approach

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A wide range of restoration efforts has been conducted in the Mediterranean, from the promotion of autogenic restoration to a variety of reforestation activities. However, rigurous evaluation of the degree of success of restoration actions is rarely carried out. REACTION project aimed to define an analytical framework, criteria, and methodology for the evaluation of restoration efforts in the Mediterranean, and to establish a database on evaluated restoration projects. REACTION approach lies on three main elements: (1) degree of achievement of specific project objectives, (2) comparative analysis between pre-restored, degraded conditions and current conditions, and (3) land quality assessment. The approach results from the trade-off between the need for fitting to specific characteristics of any particular restoration effort and for providing a common methodology for baseline evaluation of restoration projects. The evaluation protocol tests the achievement of initial objectives but also the current quality of the restored system -in terms of structure, function, socio-economic and cultural values- according to current perspectives and social demands. It has been designed as a broad framework, with a wide variety of indicators, both qualitative and quantitative, requiring minimum field assessment and optimizing the use of existing and available information. Scales for evaluation include stand, ecosystem and landscape levels. Since the achievement of most restoration goals needs an ecologically meaningful time period, the protocol is mainly designed for *a posteriori* long-term evaluation of restoration projects. The REACTION protocol has been successfully applied to evaluate and compile information on more than forty long-term restoration projects in the Northern Mediterranean countries.

Keywords: Evaluation methodology, forest quality, long-term assessment reforestation, restoration success.

A set of principles of ecological engineering

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During the last years a set of ten principles of ecological engineering has been developed. The principles are based on research which has led to a dissertation in 2004 and are fully described in a recent publishe book (March 2005) with the title: Ecological Engineering; Bridging between Ecology and Civil Engineering. During the presentation the usefulness of the proposed set of principles of ecological engineering will be illustrated by concrete examples within the different fields of civil engineering in urban and suburban environments, including roads and motorways. It will show the wide range of possibilities to integrate social, ecological and economical (people, planet, profit) aspects towards an optimal form of ecological sustainability. The examples will be in the field of fauna provisions to decrease the negative effects of roads and motorways, the use of vegetated roofs and the usefulness of growing and using renewable materials in the building, and the hydraulic engineering sector. It shows the positive effects of (eco)system thinking for reducing negative effects of human interventions as well as the possibilities of promoting ecological values in roaddesign and roadconstruction and other civil engineering projects.

Keywords: ecological engineering, ecological sustainability, civil engineering.

Quantifying and Mitigating The Effect of Roads and Traffic on Australian Wildlife

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The network of major roads in Australia and around the world continues to expand as new roads are built and existing roads widened. The effects of roads and traffic on wildlife are potentially numerous and profound. The ecological effects of roads and traffic are compounded by other causes of habitat loss, which has been so extensive across much of Australia that many landscapes currently support less than 5 – 10 % tree cover. Ironically, much of the remaining habitat occurs adjacent to formed roads or in unused road reserves. Consequently, new roads dissect these vegetation remnants, potentially disrupting the movement of animals. Similarly, the widening of existing roads will typically result

in the removal of habitat. Numerous projects across Australia have recently been initiated to mitigate the negative effects of roads and traffic. We will present a number of case studies from eastern Australia where attempts to restore habitat and connectivity have been implemented. We will discuss the effectiveness of these measures and will highlight a bold research initiative to quantify and mitigate effectiveness by focusing on the population-level effects. This research is a collaborative project between University and a road construction agency and is sponsored by the Australian Government. It will combine three techniques (empirical observations of animal movement, genetic analyses and metapopulation modeling) to specifically address questions related to the barrier effect of roads on a diverse range of taxa, including mammals, reptiles and invertebrates. The effectiveness of mitigation measures will then be assessed by quantifying changes to population viability.

Keywords: Road ecology, Road mitigation, Restoration ecology, Australia.

Biogeochemical regulation of metal availability in wetland sediments by sulphur and nitrogen

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As a result of intensive agriculture in the Netherlands, high concentrations of nitrate are found in surface water and groundwater of many freshwater wetlands. In waterlogged (sub)soils, sulphide containing deposits (mainly iron sulphides) are oxidized by the chemolithotrophic microbial reduction of NO_3, thereby increasing sulphate concentrations in the groundwater. Depending on the actual pH, pyrite-associated metals may simultaneously be released into the groundwater. In field experiments it has been found that increased NO_3 pollution can indeed lead to oxidation of iron-sulphides and decreased sulphate reduction. This could also be demonstrated in controlled mesocosms.

High NO_3 concentrations can, however, also act as a redox buffer, thereby decreasing the mobility of metals in the sediment. Although this may be beneficial for toxic metals, it may also lead to deficiency symptoms in plants with respect to essential metals like iron. Based on field observations and microcosm experiments, the present paper will discuss the mechanisms by which S and N pollution may interfere with metal biogeochemistry and indicate the implications for metal toxicity assessment.

Keywords: pyrite, nitrate, metals, pollution, biogeochemistry.

Dealing with societal support in ecological restoration. The case of the Green River Plan in the Netherlands

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It is generally accepted that support from stakeholders and citizens is essential for successful ecological restoration. However, it is less clear what this means for the process of decision-making and the role of ecological expertise. We studied the decision-making of the so-called Green River Plan in the Netherlands. This plan aims to restore a brook valley system in the Netherlands and was proposed by nature protection organizations. Beside conservationists other interest groups as farmers, water managers, city planners, landscape protectionists, and industries are involved. Top-down decision-making is thought not to be successful since some stakeholders are able to block the process. The main actor, the provincial government, has therefore chosen for an interactive procedure to require participation of all stakeholders. So far, this approach seems to be successful. All stakeholders, including local authorities, support the plan to restore the brook valley. However, it appears that it is very difficult to get an agreement on issues like the location of the restored brooks and the size of the brook banks. It can be questioned whether ecological knowledge is adequate to solve these disputes. Beside interests, ecological expertise is not considered as sufficiently reliable and transparent to all actors. Moreover, science and technology studies have learned that it is important that knowledge is socially robust. This means that it can be linked to other types of knowledge and approaches. In other words, ecological expertise should be robust in different social contexts, and modifiable to some extent. We conclude that this requirement of ecological expertise may easy be underestimated in restoration projects.

Keywords: social robustness, ecological expertise, stakeholders' view, decision-making.

How important is water dispersal in Restored temperate floodplains?

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Little disturbed floodplains have sharply decreased in temperate Europe and N-America and are now among the more threatened ecosystems. In order to reverse this trend, restoration is applied at an ever-increasing scale. A major goal in wetland restoration is the attempt to increase biodiversity by recreating a previous situation. This target can only be reached when abiotic conditions (e.g., water regime, nutrient availability) have been adjusted and disappeared species can re-establish themselves. Whereas abiotic conditions are mostly changed by active human intervention this is much less the case with biotic elements. Generally restorationalists rely upon spontaneous dispersal of organisms. In the case of flooded wetlands propagule dispersal by water is expected to contribute much to a fast biodiversity increase in restored sites. In the present contribution we will explore the importance of water dispersal for the conservation and restoration of biodiversity in flooded wetlands, both in more natural and in more regulated settings. We will also investigate which traits favour water dispersal and how important this phenomenon is for restoration.

Keywords: restoration, floodplain, biodiversity.

Nutrient-enrichment, habitat homogeneity, and fragmentation limit the recovery of the aquatic invertebrate fauna of raised bogs

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To study whether bog restoration rehabilitate fauna diversity, we compared the aquatic invertebrate assemblages between pristine Estonian bogs and rewetted and non-rewetted bog remnants in The Netherlands. The microinvertebrate fauna (Rotifera, Copepoda, Cladocera) recovers quickly after rewetting. However, this is not the case for macroinvertebrates, like dragonflies and beetles. This difference in response is probably due to the less complex lifecycle of microinvertebrates and their easy dispersal by wind. Until now rewetting resulted in fairly similar macroinvertebrate assemblages, including only part of the species spectrum of pristine bogs. Water bodies in bog remnants that are not influenced by rewetting measures are inhabited by higher numbers of characteristic macroinvertebrates than rewetted sites. Therefore, we recommend to take care of present populations of rare and characteristic species, as these may become the sources for colonisation of rewetted sites. Sudden changes induced by large-scale rewetting should be avoided. Increased nitrogen deposition hampers restoration of the species assemblages of nutrient-poor bog pools. Species preferring water bodies with a higher nutrient availability within pristine bogs are dominant in The Netherlands. Furthermore, the heterogeneity in (a)biotic conditions and transitions to minerotrophic parts of the bog system, required by species to complete their lifecycles, are not yet restored in bog remnants.

Keywords: bogs, invertebrates, nutrients, heterogeneity, fragmentation.

Biological traits succesfully predict the effects of restoration management on macroinvertebrates in shallow softwater lakes

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Many shallow softwater lakes are being affected by eutrophication and acidification. In these small lakes a sapropelium layer develops and characteristic plant and animal species are disappearing. In many degraded lakes organic matter and macrophytes are being removed in order to restore the lakes in their original state. To assess the effects of restoration management in softwater lakes on aquatic macroinvertebrates, changes in the species assemblages were studied in four degraded lakes undergoing restoration measures. The degraded lakes still harboured species characteristic for pristine softwaters. However, most of these species were not recovered after restoration measures were taken. Species' densities declined dramatically during the execution of restoration measures. Swimming and abundant species were more likely to survive the restoration measures than other species. The first years after restoration measures were carried out, the lakes did not meet the habitat requirements for

a number of species. Species requiring vegetation for ovipositioning, animal food sources and swards of vegetation as habitat, declined or disappeared. Because recolonization is expected to be restricted, it is recommended to ensure the survival of relict populations when taking measures to restore degraded softwater lakes. This may be achieved by phasing restoration measures in space and time, hereby minimizing mortality during the execution of restoration measures and by preserving habitat conditions required by characteristic species.

Keywords: restoration ecology, acidification, eutrophication, degradation, life cycle, bottleneck.

Effects of the current management regime on the entomofauna of calcareous grasslands

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Calcareous grasslands are semi-natural habitats that harbor a very rich flora and fauna. The number, size and quality of calcareous grasslands in the Netherlands have decreased sharply over the past century, due to marked changes in agricultural land use. Currently around 20 calcareous grasslands remain in this country with a total surface area of only 0.25 km^2. In these areas historical land use has been replaced by mowing or grazing. This management regime does enable many typical plant species to persist, but available data on butterflies and grasshoppers indicate that many entomofauna species may have been lost. To establish the current status of a number of species from different taxonomic groups in these grasslands a survey has been started in 2005. This survey includes some larger and less disturbed calcareous grasslands in Belgium and Germany as a reference, since historical reference data on the distribution of the entomofauna in Dutch calcareous grasslands before degradation is lacking. Next we will have a closer look at biological traits of some functional groups of species that are no longer present under the current management regime, in order to identify bottlenecks in their lifecycle. This knowledge can be used to improve current management.

Keywords: calcareous grasslands, entomofauna, bottlenecks, management, restoration.

Effects of restoration on landscape heterogeneity: a step in the right direction, or further into the swamp?

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Heterogeneous landscapes are hotspots for biodiversity. Degradation decreases local habitat quality, but on a larger scale also causes a decline of heterogeneity. Restoration measures aim at restoring the habitat quality. This inevitably causes a disturbance. If this disturbance is large scaled, intensive or unpredictable it can cause a direct loss of animal species. In addition, measures can cause a further decline of heterogeneity, by suppressing the underlying diversification processes (e.g. the influence of groundwater by rewetting). To investigate the effects of restoration measures on heterogeneity and the concomitant animal diversity, we collected aquatic invertebrates in the Korenburgerveen, a heterogeneous landscape under hydrological restoration. The situation before the measures took effect was compared with the situation afterwards. The species response is contrasted with their life history in order to expose bottlenecks in the lifecycle arising due to measures. This allows the extrapolation of the results to other species and landscape types. Guidelines for restoration, improving habitat quality without causing heterogeneity to decline are presented.

Keywords: landscape heterogeneity, degradation, fauna, life history, bog remnant.

Economic Implications of Eco-innovative Stormwater Management

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Restoring the pre-development characteristics of urban waterways involves the management of stormwater runoff that has been identified as a major transport mechanism of land-derived contaminants. The views that rainwater falling on cities should be diverted to streams and rivers as quickly as possible and that clean water is a limitless resource are questioned at present and a new approach to stormwater management is emerging. Low impact urban design and development is an eco-innovative

approach that manages stormwater by working with nature. Emphasis is placed on avoiding or minimising impervious surfaces to facilitate infiltration and utilising vegetation to assist in evapo-transpiration and pollutant and sediment trapping. The paper reviews the economic implications of applying such an eco-innovative approach using the Glencourt Place project in North Shore City, New Zealand as a case study. At Glencourt Place rainwater tanks are retrofitted to existing properties, gravel trenches are built and minimal piping installed instead of reticulating the area with stormwater pipes and increasing the capacity of downstream pipes. This pilot project is assessed based on life cycle costing using cost minimisation as a key selection criterion. The cost entries from the life cycle costing are then used to identify aspects of the project and its selection framework that either favour or inhibit the up-take of the low impact approach. Both the selection criteria and the performance of the low impact approach are evolving. Consequently, experimentation leading to experience through both success and failure becomes critical in shaping this evolutionary process that is going to influence the state of urban waterways in the future.

Keywords: eco-innovation**,** low impact stormwater management, life cycle costing, selection framework.

Monitoring Peatland Restoration using Testate Amoebae as Bioindicators

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Three UK peatlands were monitored with the objectives of assessing the potential for using testate amoebae as biological indicators of restoration and observing seasonal changes within testate amoebae communities. The sites were selected to represent recovery from the three major causes of damage affecting ombrotrophic peatland sites in the UK; drainage, forestry and peat cutting. They are all National Nature Reserves (NNRs) and are at various stages of restoration. 1) At Coom Rigg Moss, restoration has focussed on blocking drainage ditches to improve hydrological conditions. Testate amoebae communities were monitored before and after ditch blocking activity to provide a comparison of pre- and post-restoration conditions. 2) At Flanders Moss, an area is being restored following afforestation with non-native trees. Testate amoebae assemblages were monitored under different tree felling and hydrological management. 3) Fenn's and Whixall Moss was severely damaged by peat extraction, and monitoring has examined testate amoebae response to different water levels and structural elements in the cutover area. Sampling was repeated at various times of year at all sites to study seasonality of testate amoebae populations, and to minimise the impact of seasonal fluctuations on the results. Preliminary results indicate that there are several factors affecting testate amoebae populations within restored sites. Testate amoebae appear to be sensitive to surface humidity levels rather than variables measured in hydrological monitoring. They may thus be more representative of the progress of ecological restoration than conventional physical measurements such as water table depth.

Keywords: Peatlands, restoration, testate amoebae, monitoring.

Unveiling the ethical challenges behind restoration research

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Members of the ecological restoration community continue to engage in compelling conversations about ethics. The majority of the published conversation revolves around the ethical obligations and value of restoration. Yet, we have also identified subtler aspects of working in restoration that ethically challenge us. Previous studies and symposia have yielded a range of challenges, from reporting on restoration failures to using appropriate statistical tests to compare ecosystems. At the 2003 SERI meeting in Austin, TX, Dr. Ted Shear and I convened a symposium to discuss these issues. The discussion was lively, with many members expressing concern about how a code of ethics will impact or feed into the professional certification process. I aim to turn the conversation in a new direction by questioning whether a code of ethics can help researchers conduct good science with relevant results for restoration. Using my research of exotic plant invasion in urban forests, I will outline several places in the restoration process where ethical dilemmas may surface. I will also report on a current survey of restoration ecologists to further highlight these dilemmas. The goal of my current work and of this presentation is to engage the restoration community in a dialogue about how a code of ethics might move our field forward.

Keywords: ethics, exotic plants, code, survey.

Rufea wetlands restoration, Lleida, Spain

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Rufea wetlands**,** knowledge as 'aiguamolls", near Lleida city and emplaced in the first river Segre terrace, own an important ecological value, having been debased by activities as arid's extraction or uncontrolled residues flowing. These 'aiguamolls' are a humid area conformed by a grand natural meadow that serves as grass and is conformed by two rafts colonized in their borders by vegetation as stalks, sticks or rushes. They have their origin in the holes that were made for the extraction of construction materials. Due to the proximity to river Segre, the phreatic level is to little depth, and this caused that that the extraction zones were filled with water and therefore the rafts that we can observe at present were created. Apart from the shore vegetation, different communities of wetland bird species can be watched in this area. The exploitation of the resources of this area finished during the 80's ,because of the increase of the control in arid's extraction, but another of the problems that have caused the deterioration of the wetlands has been the illegal flown of construction debris. Due to the high debasement that all this area has suffered and also because of the natural interest it has thanks to vegetation species and birds, the Lleida's Council proposed the landscape restoration of this zone,with the aim of recovering and promoting all the environmental values of Rufea wetlands**,** and beginning the formation of a corridor, which axis would be the river Segre and which extremes would be "La Mitjana", natural protected area, in one side, and Rufea wetland in the other, inside Lleida's municipality. The main aim of the restoration works in this zone of Rufea that the council of Lleida proposed has been to recover an area that, because of its natural value, has a high social interest for Lleida's city, because of the possibility it offers to carry out some birds observation and environmental education activities and to promote the respect to the environment. That's why it has been proceed to retire construction residues, to clean the borders of the river, to create a new raft as to promote birds arrival, as well as to endow some environmental equipments and to forest in the perimeter and the surroundings of the zone with different plants related to the phreatic level of the river.

Keywords: restoration, river Segre, meadow.

Urban Parks and Environmental Sustainability: Design Strategies

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Urban parks provide many benefits that improve the quality of life of the citizens. This research project focuses on the contribution of parks to environmental sustainability. The condition of the three biggest urban parks was analyzed and compared in two cities (Fuenlabrada, Spain; and Porto Alegre, Brazil) in terms biodiversity, accessibility, connectivity, and water and soil resources protection; using sustainability indicators from Agenda 21 and the Montreal Process. Green structure vitality, carbon storage and air quality improvement were also addressed by applying the UFORE Model from the USDA Forest Service. Primary data was collected in 15 random plots in each park, and later translated into a rating scale for comparison purposes. As a result of the study, accessibility to parks was found to be superior in the city of Porto Alegre, while universal access within parks was greater in Fuenlabrada. Biodiversity rated higher in parks containing remnant or protected ecosystems. Regarding vitality, parks with a larger percentage of native species were in better condition. Green structure connectivity and carbon storage were superior for the oldest parks. While in Porto Alegre urban parks protect water bodies, in Fuenlabrada soil protection from erosion and compaction was greater. On air quality improvement, urban parks' removal rates were higher for ozone and nitrogen dioxide in Fuenlabrada, while in Porto Alegre rates were higher for removal of carbon monoxide and sulfur dioxide. Specific recommendations were made to influence city planners and decision-makers to support actions that maximize the environmental benefits of urban parks.

Keywords: urban parks, environmental sustainability, sustainability indicators, air pollution, air quality.

Response of *Eucalyptus saligna* plantations infested by exotic *Paspalum* after restoration treatments to enhance native biodiversity

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Sixty hectares of 30-year old *Eucalyptus saligna* plantations with exotic pasture (*Paspalum*) understorey were included in recent expansion of Bongil Bongil National Park on the New South Wales North Coast, Australia. These plantations are dissimilar to nearby native forests and require restoration to improve biodiversity values. We identified potential biotic barriers to the natural succession of these plantations to more natural forest: (1) competition and suppression by the dense paspalum sward and litter, (2) competition from the unthinned eucalypts, (3) the absence of a native seed bank, (4) lack of germination cues for any in situ or persistent native plant seed bank, (5) wallaby browsing of woody seedlings in the event of any regeneration. We therefore implemented restoration treatments to overcome these biotic barriers. The treatments included canopy reduction of plantation trees and understorey manipulations (i.e. burning, rotary hoeing, weed control, wallaby-exclusion fencing, and planting native woody species). Results of initial post-treatment measurements of top soil chemistry, biomass, ground cover, canopy density, composition and structure of trees and shrubs, seed bank, light intensity, and survival and growth of seedlings, will be presented.

Keywords: Restoration, Biodiversity conservation, *Eucalyptus saligna, E. pilularis,* Plantation, Exotic *Paspalum.*

Restoring Wetlands For Recreational Activities and Public Use. The case of Benicàssim Marsh

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The aims of the restoration work planned for the marsh known as *Marjal del Quadro de Santiago* (Benicassim, Castellón) focus on recovering its ecological character and using it for social ends. One of the main issues to be reconciled has been ensuring that the ecosystem coexists as naturally as possible with existing urban conditions and those planned for the near future. One important aspect of the project has been to involve local stakeholders in decision-making. The public use actions planned in this restoration project involve developing environmental education and recreation programmes. The target population of the actions comprises the residents of Benicassim and tourists who holiday on the adjacent beach given the wetland's proximity to the town and the tourist area and to the way the wetland land is classified. The results of the study focus on 1) drawing up an inventory and evaluating natural and cultural resources and developing educational and recreational potential; 2) studying real and potential demand (visitor profile, frequentation study, etc.); 3) determining the wetland's recreational carrying capacity and; 4) the proposed activities to be introduced. The conclusions point to an interdisciplinary project. Although more time-consuming because of the need to reconcile proposals from the different groups involved (from technical experts to politicians and NGOs), it offers the advantage that the results are agreed upon by all local stakeholders, thereby avoiding conflict and ensuring the conservation of the area.

Keywords: urban wetland, environmental education, recreational activities, social participation.

Recovering the ecological character of a mediterranean wetland through topographical and hydrological interventions

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This paper analyzes the possibilities to restore the Quadro de Santiago Marsh, in Castelló (Spain). This Mediterranean wetland is a palustrine ecosystem supplied by groundwater. Its geomorphological origin is linked to a barrier-lagoon model, in which a sand barrier is closing the pond and isolating it from the sea. Nowadays, this wetland is highly altered by human actions. First reclamations in the area are

linked to agricultural practices; relevant town-planning interventions with tourist purposes are the more recent ones. In fact, the hydrological dynamic is regulated by hydraulic pumps and the wetland natural resources are degraded. Nevertheless these difficulties, a inter-disciplinary restoration project was designed for recovering the ecological character of the site. This project is based on interventions in the hydrological system, topographical remodelling and forestation actions, all of them focused to create ponds. These interventions have taken into account the salinization risk coming from the sea waters and the safeguard of the existent buildings. Moreover, it is considered the public use, according with the needs of green areas of the local people. All this work has been supported by GIS tools.

Keywords: wetland restoration, urbanization pressure, public use, GIS.

Watershed Development Practices for the Ecorestoration in Tribal Area - A Case Study in Attapady Hills in South India

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Attapady is located in the northeastern part of Palakkad district in Kerala, in South India. The Attapady valley differs from the rest of the humid tropic area in Kerala State, mainly because of the rainfall characteristic caused due to its peculiar geographical location and physiography. This in turn considerably affects the water availability, soil characteristics and vegetation. The annual rainfall decreases from West to East of the valley. Average rainfall of western area is 2500mm/year where as eastern region gets rainfall less than 600mm/year. Factors such as degraded wasteland and general backwardness of the area with large tribal population make Attapady hydrologically and socially unique. There has been drastic change in the Attapady ecosystem during the recent past, due to deforestation and migration. The hills of Attapady were once the forest land of Kerala. At present it is on the verge of extreme degradation. Studies shows that the forest area in the Attapady region has reduced from 406 (km) ^{2} to 164(km) ^{2}. No area was shown under barren in 1971, but at present 233.8 (km) ^{2} is identified under this classification. The main inhabitants of this area are tribals, who forms the most socially and economically weaker section of the society. These tribals earn their livelihood from agriculture and forest produce.

This paper explains how ecorestoration project is being implemented with people's participation and its impact on natural resource management and livelihood of the watershed inhabitants.

Keywords: Ecorestoration, people's participation, Attapady.

IAGF index application to asses hydromorphological status in colluvial rivers. Case study: morphological changes on Tormes river

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We have tested feasibility IAGF index to asses hydromorphological status in colluvial rivers, where flow regimes and rates of hillside sediment condition river morphology. This reach is located on Tormes river, a siliceous river in Gredos range (Central Spain). This reach was altered in 2001, when channel planform was changed and coarsest sediments from the channel were removed to build structures on the left riverside in order to prevent hillsides erosion damages. This disturbance made the reach wider and provided an artificial substrate composed mainly of fine sediments. Since then, and specially due to 2001 high flows, channel has almost returned to its previous morphological condition.

We have used IAGF index to determine hydromorphological status before and after the disturbance. Morphological features as channel width and depth, flow velocities and sediment size were measured in field surveys developed from 2000 to the present time. In these sampling campaigns electro-fishing surveys were also made so as to determine fish community and brown trout population parameters. Results obtained from both methods along this period were compared and we found that highest values in IAGF index (corresponding to natural conditions) agreed with the best quality values of brown trout population parameters. These results seem to indicate positive correlations between morphological and biological status recovering. We conclude that IAGF is a useful tool not only to assess current hydromorphological status on colluvial river reaches but also to evaluate its potential capacities and to predict its morphological evolution after disturbances.

Keywords: IAGF, fluvial geomorphology, Hydromorfological status, biological status, evaluation.

Impact of water-level fluctuation and herbivorous water birds on the expansion of emergent vegetation along lake shores

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Water-level regime may be used to promote the expansion of emergent vegetation along lakeshores. However herbivorous water birds can have an important impact on this expansion. We present the case of Volkerak-Zoommeer in the Netherlands, a fresh water lake created in 1987 after the enclosure of an estuary. It was demonstrated that a rigid water level prevents the re-establishment of emergent vegetation. Using an enclosure of 3 ha in which the water level could be manipulated it was shown that partial summer drawdown of the water level created suitable conditions for germination and growth of tall emergent species, in particular *Phragmites australis*. Plant survival and expansion depended on subsequent water-level fluctuation and grubbing by wintering Greylag goose (*Anser anser*). Results from exclosure experiments indicate that wild population of winter greylag goose could suppress the development and expansion of tall helophytes completely. Grubbing by Greylag geese also proved to be related to water level. They only foraged on rhizomes from inundated helophyte species. It was shown that rigid water level and grubbing by herbivorous water birds can be important inhibiting factors in the re-establishment of tall emergent vegetation along lakeshores.

Keywords: Helophytes, lakeshores, *Phragmites australis*, Greylag goose (*Anser anser)*, water-level fluctuations, herbivory.

Ecohydrology – system approach to sustainable development of water resources

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Sustainable functioning of freshwater ecosystems depends on maintenance of homeostatic equilibrium which is determined by its natural characteristics achieved during biogeochemical evolution. This may be seriously diminished by uncontrolled human activities, leading often to degradation of energy flow and water and biogeochemical cycles in catchments. Therefore, one of the fundamental aspects in integrated approach to freshwater management is understanding of interplay between abiotic - hydrological template and biological processes in the catchment. The system approach to water resources management has been expressed in the framework of Ecohydrology Concept as three principles: 1) Integration of hydrological cycle and biota dynamics in a catchment scale; 2) Enhancement of absorbing capacity of ecosystems against human impact; 3) The use of ecosystem properties as management tool. The application of the concept is based on a 2-way regulation: Shaping biota structure, which can be applied towards optimizing the system retentiveness against nutrients and pollutants, stabilizing ecological resilience and resistance of the system against stress, and mitigation hydrological extremes. The vice versa regulation based on control of hydrological processes for regulation of biota dynamics. Based on the results of long-term studies, the paper presents also an example of scientific background for application of Ecohydrology toward protection of the Sulejow Reservoir (Pilica River, Poland) against eutrophication. Analysis of the variability of the chemical composition of the reservoir tributaries on the background of their hydrological pattern enabled the identification of episodes of the highest nutrients transports. This was a basis for elaboration of control of floodplain processes, in order to optimize sedimentation and assimilation of phosphorus by primary productivity of valley vegetation and enhance purification processes. The proposed system provides also socio-economic benefits for local communities and is concordant with Poland's obligations to comply with European Directives. The project has been developed in the framework of the Demonstration Project under the auspices of UNESCO and UNEP “Application of Ecohydrology and Phytotechnologies for Water Resources Management and Sustainable Development”.

Keywords: catchment, eutrophication, Poland.

The International Long Term Ecological Research Network: Lessons Learnt and Potential for Guiding Restoration Ecology

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A key issue in restoration ecology is determining the goal of restoration. Ecosystems change over time as a result of both natural and anthropogenic processes. Determining desirable ecosystem characteristics and the acceptable parameters of those characteristics requires a thorough understanding of the previous and possible future dynamics of the ecosystem being manipulated. Unfortunately, processes affecting the long-term dynamics of ecosystems have too frequently been studied only through short-term observations and experiments. Hence, the potential impacts of processes that are transient, intermittent, infrequent, and/or slow to produce an effect are often poorly known. Inadequate knowledge of these impacts makes it difficult to design a restoration program that maintains or enhances a sustainable ecosystem. The International Long Term Ecological Research Network, now encompassing 30 countries, focuses on an improved understanding of ecosystem processes that have long-term actions or effects. An overview of the goals of this network will indicate how long-term studies are important to restoration ecology and will be supported by specific examples of restoration projects from the ILTER Network.

Keywords: long-term, ecosystems dynamics, ecosystem processes, international, LTER, restoration.

Challenges of ecosystem restoration in a changing environment

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The ease and permanence of the restoration/rehabilitation of ecosystems depends upon how well the ecology of a given area is understood. This knowledge forms the basis for assessing the physical stability of land areas, the amelioration of the substrate, potential of biomass production, consumer food supply, and as a consequence, the ecosystem services for humans, their support systems, and other biota. On all of these, the knowledge gained in the last three or so decades has been both substantial and substantive. Our present knowledge is based on climatic conditions that we assume/hope will be within a known range of variability; hence the implicit expectation that ecological amplitudes of species used in restoration will, to a large degree, be well within the range of extant conditions and predictability. Now, however, an enormous body of literature clearly points to a change in climate that may well thwart the successional patterns of species populations that we have documented thus far. This presentation will review the evidence of climate change based on direct observations, the so-called proxy data, and meta-analyses of organismal responses that have a direct bearing on ecosystem restoration. These challenges will be enormous and some strategies to cope with them will be presented.

Keywords: restoration, rehabilitation, climate change.

Restoration as Succession in Terrestrial Systems

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Ecological succession is a central concept in ecology yet the linkage between ecological succession and restoration concepts has been rarely exploited in practice. Restoration from a successional approach is essentially the manipulation and sometimes the acceleration of succession to a desired endpoint. Patterns of successional development can offer reference systems for the assessment of restoration actions. We will identify a range of restoration types on the basis of different spatial scales, ecological drivers and restoration goals. Data will be presented from restoration activities around the world that come from habitats representing gradients of precipitation, temperature, soil age, soil stability, soil fertility and soil toxicity. These contrasting environments provide the challenge in developing a new, broadly based paradigm to link succession with restoration. Our central question will be: What is the minimum amount of ecological information needed to restore a specific landscape or area? We will define what part of that information comes from successional theory and which key environmental drivers can be used to improve and measure restoration success. Using threshold values, we can establish the relative success of particular restoration strategies. New approaches

are needed that benefit both the theoretical basis of succession and the practice of restoration. The urgency to repair damaged landscapes makes it critical to search for generalizations about the process of restoration. We suggest that re-examining restoration in the light of succession will aid in this search.

Keywords: Reference systems, restoration, succession, thresholds.

Maungatautari: scaling up restoration approaches to recover a lost ecosystem

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Despite protection, the biodiversity of New Zealand forests is gradually declining through the persistent pressure of introduced pests. Over time, local communities note evidence for this degradation in the ongoing decline and/or local extinction of wildlife species, and attribute lower values to reserves as a result. At Maungatautari, we are attempting to reverse this degradation by scaling-up and adapting restoration approaches, that are still recent advances in smaller areas, to this strategically located but previously neglected 3400 ha old-growth forest reserve. These approaches are: (a) construction of a pest-proof fence to prevent reinvasion; (b) eradication of a suite of introduced mammals inside the fence; (c) translocation and re-establishment of lost wildlife; and (d) deep-rooted involvement of the local community in the restoration. None of these approaches has been applied at this scale before in New Zealand, or to a forest so accessible to people. Currently we have achieved pest eradication over pilot areas totalling 100 ha, and have fenced almost half the 47 km perimeter fence. Plans are also well advanced to re-establish kiwi at the reserve this year. As a result of renewed interest in the reserve, 10 uncommon species have been either rediscovered or newly discovered, increasing the perceived value of the reserve. The conservation gains so far are, however, modest compared to the huge swell of public interest and enthusiasm generated for the project. This project's success is an important step in applying intensive restoration to increasingly large areas, and in restoring links between biodiversity and people.

Keywords: forests, pest proof fence, restoration, New Zealand, biodiversity awareness.

The effects of grazing and management measures on the vegetation of the "Dehesa"- an agro-ecosystem formed during centuries by agro-silvo-pastoral exploitation

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The decline of open biotopes as well as their adapted flora and fauna caused by abandonment or intensification of cultivation represents a global problem. Above all, the ecosystems, which are characterized by natural (e.g. riversides) or human created disturbances, (e.g. extensively used fields) are threatened. The dehesas in Spain and Portugal, as an example of an agroecosystem with a very high biodiversity, are the result of multifactorial use by different livestock, firewood and cork production as well as extensive agriculture exploitation over several centuries.Due to the changing production conditions(mainly in the 20th century), many dehesas were abandoned or their management system were simplified through specialization of the production. With the abandonment of the multifactorial use, and within mainly the abandonment of the pig-breeding due to their feeding and rooting behaviour, the disturbance factors vanish. As a consequence of this, the effect of grazing and cultivation on the mediterranean vegetation was examined in a well-preserved dehesa (open woodland with *Quercus ilex* and *Quercus suber*) in Andalusia (Spain) with the help of vegetation samples of permanent plots. The grazing contained mixed herds of pigs and cattle as well as the separate keeping of both and also fallows as reference areas. The cultivation activities which were included were ploughing, mulching and burning. For the evaluation, functional plant traits were also used. With detrended correspondence analysis of the vegetation samples both, the effect of the different grazing regimes and the cultivation activities are shown.

Keywords: grazing, pigs, cultivation, dehesa.

From sea to source: Handbook on fish migration issues

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The fish stock in rivers is one of the parameters for improve the ecological status according to the Water Framework Directive; related to this fish stock is the possibility for fish to migrate. In many rivers and waterways there are serious barriers so the possibilities for fish to migrate are poor. Well-designed fish passages have proven to be effective ways to solve this problem. Besides the positive influence on fish populations, fish migration measures also have a positive influence on all other organisms in the water systems. Water managers have a lot of knowledge of the water bodies they are responsible for. However, in many water management organizations there is a lack of knowledge how to tackle the fish migration problems. The project group "Community Rivers" (INTERREG IIIC program of the EU; 2004-2006) agreed to create a handbook "fish migration". Besides the creation of the handbook there will be research and monitoring of different types of fish passes. An other target is the development of a fish pass suitable for the conditions in Mediterranean rivers. Throughout Europe fish migration measures are executed. Every solution for fish migration problems is welcome for the fish community, but it is better to solve the problems in an organised and structured way.

Keywords: fish migration, fish passages, handbook, problems, solutions, design.

Restoration Planning in Clayoquot Sound, British Columbia, Canada

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Clayoquot Sound is a 350,000 ha area located on the West Coast of Vancouver Island - British Columbia. It was well known internationally (during the early 1990's) for having the largest scene on civil disobedience in Canadian history, for the protection of coastal temperate rainforest. As a result of changing public opinion about forestry practices, government brought in the more stringent Forest Practices Code for all of British Columbia. In Clayoquot Sound, further changes came with the development of the Clayoquot Sound Scientific Panel Recommendations (CSSP), which set out forestry practice requirements that followed ecosystem based management practices (EBM). 87,600 ha of parks were created, comprising approximately 33% of the total area of Clayoquot. The annual volume of timber extracted from this area dropped dramatically from a peak of 1.2 million cubic metres, to approximately 200,000. While any timber extraction after 1995 followed the CSSP recommendations, much of the area of Clayoquot that had been harvested required extensive restoration. As funding levels for restoration were not sufficient to address the entire past ecological damage, a Landscape Level approach for ecosystem restoration was required to prioritize the type, intensity and location of restoration. From the Landscape level, sub-regional planning followed, then to watershed, and finally site level.

Keywords: Clayoquot, rainforest, planning, watershed, restoration.

Evaluating restoration success in subtropical dune forests in South Africa

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How do you know when restoration is successful? This vexing question has kept many minds occupied for the last twenty years or so. The problem can be approached from many angles, amongst which the most important ones are probably economic, social, and ecological. Here we present part of our ecological assessment of the dune forest restoration program of a mining company in South Africa. We used data from both temporal surveys (up to seven successive surveys on the same sites) and space-for-time surveys of assemblages from several trophic groups to evaluate ecological trajectories in community structure and composition on rehabilitating sites. In the past we have done this on a broad scale, assuming that variability in values across sites of the same age (but sampled at different times) represents statistical error alone. Here we present a more site-specific analysis, where we effectively use a test of the chronosequence assumption to point out sites that are changing differently over time to what a space-for-time pattern predicts. The chronosequence assumption predicts that the rate of change in a variable between sites of successive age (dspace), and the rate of change of the younger site over time (dtime) should be the same. The slope of the relationship should thus not be different from 1. This allows man-

agement to be adapted to focus on potential problem areas in rehabilitation. We found that 1) surprisingly many (two thirds) of the slopes across all variables and groups were not significantly different from one, 2) in half of the cases changes over time were in the same direction as changes across space, and 3) in two thirds of the cases changes were in the "correct" direction. Our results show that the chronosequence assumption is a relatively robust basis for analysing patterns in community development in rehabilitation. It further identified several sites that needed more investigation or management actions.

Keywords: evaluating restoration success, dune, South Africa.

Will Urban Estuaries "Survive" the 21st Century? Society Induced Criteria for Preservation, Conservation and Restoration Success

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Urban estuaries are dominated by human presence and extractive uses. Concomitantly, management decisions are generally weighted toward anthropocentric versus ecocentric criteria along the dual mandate continuum. This is not to say that ecocentrism is unimportant, rather the baselines have shifted and ecological considerations reflect "cross-cutting" criteria that benefit both people and other biota such as clean water and sediments, and preservation and conservation of remaining "natural" habitats. The latter often serve as source habitats for propagules, increase biodiversity, and can serve as places where growth and survival of young is enhanced. We do not know whether the relatively small remaining wetlands, oyster reefs, sea grass meadows, flats and other habitats continue to play a significant role in donor-control; i.e., whether secondary production in open waters of the estuary would be significantly increased beyond the capacity of those waters to support *in situ* production. In a restoration context, the "hard decisions", and the ultimate compromises and sacrifices that will be required to sustain urban systems and their remaining functional habitats are the subjects of this paper.

Keywords: urban systems, donor-control, restoration.

Creating Substrates from Wastes for Habitat Re-Creation

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Utilising wastes for ecological restoration requires the resulting substrate to be fit-for-purpose and safe. In a preliminary study we compared the establishment of native broadleaf woodland species in mineral quarry waste amended with either controlled-release mineral fertiliser (MinF) or an organic mix of biosolids and papermill fibre (OrgF). The OrgF was better suited to habitat re-creation because it stimulated both plant biomass and soil microbial biomass whereas MinF had no effect on microbial biomass after three growing seasons, although plant biomass was comparable in both treatments. Wastes diverted from landfill (papermill fibre, biodegradable fraction of municipal solid waste, green and catering wastes) were co-composted in various combinations in-vessel and then tested for human pathogens to assess the suitability of the end-product for restoration purposes. Temperature maxima during composting and duration of the maturation phase appeared important to the reduction of pathogen colony-forming units. We are currently developing approaches that demonstrate the use of compost to establish oligotrophic, acidic habitats by incorporating inert mineral waste (secondary aggregate processing fines) for nutrient dilution, and either chemical (S) or natural (conifer wood recyclate) agents for acidification. In conclusion, substrates created by rapid, in-vessel composting of organic waste streams can be used safely for the ecological restoration of a range of habitat-types of high conservation value.

Keywords: ecological restoration, in-vessel composting, microbial biomass, mineral waste, pathogens.

Networks in Restoration: An Ecology of Network Interaction

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Much of the continuity of restoration activity is generated by the energy of peer-to-peer networks, whether they are networks of practitioners generating experience and solutions, or communities invested in the historical and future health of restored systems. Peer-to-peer networks can outperform organiza-

tions because of their flexibility, agility, and because they are self-correcting and self-organizing. This is a well-known phenomenon in social and ecological systems, but that peer-to-peer networks require subsidy and infrastructure to persist through time has not been considered in the literature to date. Networks require a resource base, a substrate, an energy source - either through arbitrage or direct subsidy, and the quality of the resource or resources inform the character of the network. We propose a correction of network theory based on Tainter et. al. (2003); on the notion that the richness, density, and performance of networks is a function of resource quality, whether energy gain in natural or material networks or value transfer in human networks. Our corrected network theory then becomes a link to understanding the relations between social networks that process symbols and natural systems that disperse energy. We believe that understanding this link is a critical part of assessing successful restoration, and planning for future success.

Keywords: networks, community, social, restoration success, energy.

An Integrated Approach to Forest Restoration

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The impacts of several major fires and subsequent biotic grazing on post-fire regeneration have resulted in the loss and fragmentation of two forest species on Rottnest Island, Western Australia. The Rottnest Island Authority, agency responsible for environmental management on the Island, seeks to restore a relative abundance of *Melaleuca lanceolata* and *Callitris preissii* forest species by 2020, to provide wildlife habitats and to enhance the recreational amenity of the Island. Restoration efforts on the Island have had varied success due to the ad-hoc application of restoration measures and a limited understanding of the habitat requirements for the restoration of woodland species. This lack of baseline information is in part due to limited communication between researchers and management to tailor research to management objectives. A study was undertaken to examine the spatial and temporal dynamics of forest restoration sites on Rottnest Island, Western Australia, to develop a model to target suitable restoration sites. Geographical Information Systems (GIS) technology was used to study the environmental and biotic factors influencing the growth of forest species within restoration plots and suitable site conditions for individual plant growth were identified. In turn, a model to target future restoration sites was developed using restoration scenarios designed in conjunction with management. The development of restoration scenarios with the Rottnest Island Authority and relevant wildlife organizations was instrumental for the integration of scientific research findings into landscape management practices and policies.

Keywords: forests, habitat restoration, integration, GIS.

The broad adult niche and artificial range extensions in restoration

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For many species, the recruitment niche is narrower than the dispersal niche (only individuals in “safe sites” establish), and natural species distributions may be reflections of this bottleneck. Conversely, in many species adults can flourish in habitats where they cannot successfully reproduce. This is an example of “ontogenetic niche shifts”. A broad “adult niche” may only be revealed when we artificially put adults in such environments. The existence of adult niches that are broader than recruitment niches can provide conservation opportunities (time to recognize and correct habitat changes that would otherwise doom populations), management techniques (i.e., nest boxes), restoration pitfalls (artificial range extensions), and horticultural safeguards (plantings guaranteed not to be invasive). We examine the existence of the broad adult niche, how it is revealed, and its implications for our manipulations of species, particularly in the context of ecological restoration. Assisting plantings through the early stages of recruitment is commonplace in restoration, because it is these stages are the most vulnerable to loss. However, if such assisted individuals are inadvertently established in sites or microsites where natural recruitment is not possible, then (local) artificial range extensions are possible, which can produce “relict populations” or “living dead”. On the other hand, if recruitment opportunities are simply rare, or episodic, restoration assistance might be appropriate. These situations may not be easily distinguishable. We urge restoration researchers to address these issues.

Keywords: Ontogenetic niche shifts, range extension, recruitment niche.

Restoration experiences of threatened forest Chilean species: the case of *Araucaria araucana* (Mol) Kock

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Continental Chile presents the highest percentage of endemic plant species for any South American country (51.7%) with 61% of endemism concentrated in Central Chile (34º-39º S). This area is recognized as one of the 25 global Biodiversity Hotspots due to it having the highest levels of natural vegetation substitution for artificial monoculture and ironically the lowest percentage of natural vegetation protected by the State. Because of this, the Universidad Austral de Chile together with other Institutions implemented different conservation initiatives with threatened endemic species in this region. Outstanding is the experience developed with the conifer *Araucaria araucana* (Mol) Kock for one of its coastal range population. Recent molecular studies suggest that this highly threatened unprotected population is genetically distinct from all other Chilean and Argentinean populations. It has been historically damaged due to antropic activities such as burning, cattle grazing, inadequate fruit collection and in the last three decades by the conversion to exotics plantations. Since six years ago, restoration activities have been carried out in two small properties the in situ conservation of this population. Among these are the direct seed sow and plantation, with 75 and 85% of survival. It was determined that the establishment of *A. araucana* in the area was better under well-drained soils and under remnant tree protection conditions. Among other activities was the construction of a rustic greenhouse for plant production activities and local people training. The information gathered from these experiences will allow to continue the restoration plans for the safeguard of this unique population.

Keywords: Threatened endemic species, *Araucaria araucana*, ecological restoration, small landowners.

30-yr study shows need for wetland restoration to be more strategic

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Research spanning 30 years shows that Southern California's tidal marshes are filling in due to frequent flooding and sedimentation rates that exceed sea level rise. Once a diverse salt marsh, Tijuana Estuary has experienced major sedimentation in recent decades. The marsh plain has become too high and saline for native halophytes to recover from declines that occurred in 1984. Restoration efforts involve excavation of sediments, but revegetation occurs slowly, even with plantings. Adaptive approaches are the most promising. In a 0.7-ha excavation, species-rich plantings produced canopies with multiple layers, moderate standing crop and measurable N-accumulation. A subsequent 8-ha excavation re-exposed former tidal marsh plain, but species-rich plantings did not overcome problems with salt crust formation, high transplant mortality, limited seed dispersal and dynamic geomorphology. Our ability to compare experimental treatments, including 1-ha areas with and without tidal creek networks, has produced new tools for accelerating salt marsh restoration. However, restoration of diverse marshes will be slow and in need of continual monitoring and corrective measures. Along with adaptive restoration approaches at the site scale, restoration will require better watershed management and long-term land stewardship.

Keywords: Salt marsh, Sedge meadow, Sedimentation, Vegetation, Wetland.

Vegetation dynamics and rehabilitation strategy in the Upper Minjiang River Watershed, China

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The Upper Minjing River Watershed (UMRW), which is one of the six most important tributaries of an Upper Yangtze River, is an ecologically and environmentally fragile area, due to the frequent natural catastrophes such as landslides and earthquake, and increasing anthropogenic disturbance. The forest cover decreased from 50% in the 1960s to 10% in the 1970s, even to 5%-7% along the main stream. To combat the spreading of degraded lands and to rehabilitate the vegetation along the river, the vegetation distribution and ecological succession must be taken into consideration, particularly in the hilly terrain, where the vegetation plays an important role in soil and water conservation and erosion control in the watershed. In the UMRW, 631 sample plots were randomly placed to study the soil types, current vegetation distribution, vegetation dynamics under disturbance, and potential vegetation zones before intensive anthro-

pogenic influence. The classification of different vegetation types of the UMRW was based on forest inventory and Landsat ETM satellite images. The results show that vegetation types in the landscape scale are strongly correlated to the soil types in the research area. The available vegetation information on a certain soil type can be used to deduce the potential vegetation in the degraded secondary forest, if the original vegetation information is absent. The priority areas are buffered for quick rehabilitation; the most difficult areas for vegetation rehabilitation are specified on a map. Suitable trees, shrubs and herbaceous plants were suggested for rehabilitation of the vegetation on different soil types at different elevations.

Keywords: Upper Minjiang River Watershed, vegetation dynamics, vegetation rehabilitation.

Ecological Restoration needed at a heavily degraded ecosystem, a case study from Pakistan

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This study was undertaken to identify and analyze the qualitative and quantitative impact of human use and drought on the ecology of wetlands and migratory birds. Various physico-chemical and biological parameters were analyzed and a socio-economic survey was done in Uchalli Wetlands Complex (UWC) lakes to find out the human level of dependency on these lakes. In addition, waterfowl are at the apex of the food chain and are useful indicators of the overall health of the wetland ecosystems that are highly sensitive to pollution, disturbance and drought. The Complex is a combination of three independent wetlands: Uchalli, Khabbaki and Jahlar. This site is located in the Salt Range of north central Punjab, Pakistan. In UWC the environmental pressure of drought and growing demand of agriculture has taken its toll of wetlands. The study revealed about 73% decline in the water surface area and 90 % in birds population and loss in the interconnectivity among wetlands disrupting the drainage network and the hydrological regime leading to irreversible changes in wetland quality. Several ecological factors, such as habitat loss related to siltation, pollution, expanding agricultural activities and drastic hydrological fluctuations, have induced considerable changes in the dynamics and distribution pattern of sustained biota. The shrinkage of the wetland areas is a cause for environmental concern. This highlights the rapidly deteriorating environmental status of the UWC, and stresses the need for its urgent ecological restoration. I hope the sustainable use and management options of this study for UWC will be gainfully used for management and conservation of wetlands and migratory birds in Pakistan, as well as, open the door for scientists to join conservation efforts.

Keywords: Ecological restoration, Wetlands, Pakistan.

Recovery of a protected open space, after a great forest fire

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In August 2003, the western sector of the natural reserve in Sant Llorenç del Munt i l'Obac suffered a serious fire which affected several habitats of great interest (riverside forests, holm oak woods, pine groves and rocky places). Aiming to accelerate the ecosystem's natural succession and to foster the socioeconomic recovery of the affected area, there is a series of cross-disciplinary projects being executed and coordinated by the reserve's managing body (Oficina Tècnica de Parcs Naturals de la Diputació de Barcelona), which comprise three great lines of work. The first one has to do with the recovery of the natural habitats which were affected: Minimization of the loss of fertile soil with sediment traps, reforestation of the riverside forest by planting 4,000 stems of autochthonous trees, installation of nest boxes for birds and forest chiropters, overseeing of the recovery of the aquatic fauna of the affected basin, reintroduction of the autochthonous fishes, overseeing and improvement of the aquatic environment, recovery of prey species (rabbit and partridge) and replanning of their hunting exploitation, controlling the invasion of exotic species, and overseeing the natural recovery of the plant layers in forest plots. The second line of work focuses on strengthening the socioeconomic and cultural resources of the area, with the creation of a society of forest owners to execute joint projects, the activation of a centre for cultural and traditional activities, and for applied research activities, the starting of a centre for educational activities, civic participation, recovery of historical heritage, and the reopening of areas for traditional cultivation. Finally, the aim of the third line of work is the territorial planning through teledetection techniques and geographical information systems, which centralize all the generated information and act as a basic tool for planning all the other lines, future actions and the overseeing of the natural evolution of the environment and the consequences of the measures taken. For that purpose, we use images at different scales taken from satellites, planes and aerostatic balloons.

Keywords: reforestation, sediment traps, fire, teledetection.

POSTER PRESENTATIONS

Pollen rain analysis, a tool for restoration: The cloud forest of El Rincon, Oaxaca, Mexico

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The aim of present study is to know the elements of recent and past pollen rain along a chronosequence in cloud forest of El Rincon, Oaxaca to propose ecological restoration of a highly endangered plant community. There were analyzed pollen rain samples of different seral stages of cloud forests (proximately 15, 45, 75 and 100 years after abandonment) and one sample of sediments (0.4 m depth) from Tanetze lagoon. There were identified 58 pollen types, included fern spores. Most important pollen types were: *Pinus, Quercus, Alnus, Hedyosmum*, Compositae, *Clethra, Liquidambar*, Piperaceae, Pteridophyta. *Alnus* and Malastomataceae varied along seral stages. Pollen of *Hedyosmum, Clethra,* Compositae decreased with forest maturity. *Borreria, Lopezia* and *Heliocarpus* were present in 45 yr forest. *Ilex* was abundant in 45 yr forest. *Quercus* increased with forest development. *Oreopanax* and *Ticodendron* were recorded in one old growth forest. Arboreal pollen predominated in the modern pollen rains but it was less in the fossil record. Non arboreal pollen was high in 45 yr forest and old forest of Tanetze lagoon. *Typha*, and Nymphaeaceae existed in the fossil sample but they are not present anymore. The fossil record suggests that a humid *Engelhardtia* cloud forest with Pteridophyta was replaced by a less humid forest. *Pinus* abundance is now increased perhaps due to anthropogenic activities. *Quercus, Alnus* and Melastomataceae could be used to restore actual forests. Due to climatic change may be *Engelhardtia* forest could not be restored. The fossil record allows us to understand complete ecosystem dynamics and succession.

Keywords: pollen analysis, cloud forest, Oaxaca, restoration.

Desertification, drought and rehabilitation by Cactus and Argan tree in the arid area (Jbilet of Marrakech in the South of Morocco)

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The present communication aims to show the role of Opuntia ficus indica and Argania spinosa, by firts, it 's great adaptation to drought, to reconstitute in a record time, a living and dynamic soil horizon on witch it lives; then to build up an aerial and below ground biomass permitting him to proliferate, and to other plants to settle; to enrich soil by addition of organic matter, and to allow to other links of the food chain to develop, notably the micro fauna, meso fauna same as macro fauna. This reconstitution can be seen under three angles: 1) First as successful experiment serving as a demonstration for the reconstitution of nature in arid environment, particularly in fighting desertification by using species highly adapted to drought and to hydraulic stress. 2) Then, within climate change, as a sink for greenhouse gas sequestration, particularly CO2 by roots and aerial biomass and the soil organic matter and CH4 from enteric fermentation due to lipid richess of Argan pulps used for livestock feeding. 3) And last, as a reconstitution and reserve of biodiversity particularly for micro, meso and macro fauna. Indeed, Jbilet Cactus and Argan tree, attracted many observers and researchers, particularly biodiversity conservationists. Jbilet Cactus has been considered as a Site of Biological an Ecological Interest (SIBE) where introduced dorcas Gazelle which seems to find its biotope and shows a progressive dynamism.

Keywords: Opuntia Ficus indica, Argania spinosa, rehabilitation, Arid zone and South of Morocco.

Selection of woody species for wastewater enhancement and restoration of riparian woodlands

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The growth and nutrient incorporation uptake capacity of ten tree species was evaluated with the end purpose of selecting species for restoring riparian woodlands by dendrodepuration or green tree filtering, for the recuperation/reutilization of treated wastewater. Trees used for the experiment were grown in pots containing a perlite and vermiculite mixture for an inert substrate and were irrigated with either a fertirrigation control or with treated wastewater. No significant differences in growth or nutrient uptake were observed, yet clear, significant differences in root and shoot biomass, with the wastewater irrigated plants having the higher ratio of this value. Elemental analysis showed high concentrations of phosphorus in *Pistacea terebinthus*, potassium in *Nerium oleander* and *Vitex agnus castus*, and sodium captation capacity in *Tamarix africana*. Taken together, of the ten species screened: *P. terebinthus*, *N. oleander*, *T.*

africana and *V. agnus-castus* showed the best capacity for nutrient uptake and sequestration and purification of residual treated wastewater.

Keywords: Treated wastewater, woody plants, nutrient content, hydroponic culture.

Lake Smir restoration in the NW of Morocco

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Lake Smir is a small coastal wetland in the NW of Morocco. Equipement ministry carried out a management in the eighties by the construction of the Smir dam. This involved modifications of dimensions, the physicochemical characteristics and biodiversity of the lake. In the nineties, the restoration of the lake was carried out by the construction of the Marina Kabila even if water became salt. Dimensions and biodiversity of the lake were restored. The lake currently fully plays its part of wetland of the area and has a qualification of ecological and biological importance wetland.

Keywords: Lake Smir, restoration, Morocco.

Plant species richness and composition in rehabilitated zones of a Bauxite Mine (Los Pijiguaos, Bolívar State, Venezuela)

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CVG-Bauxilum carries out a vegetation rehabilitation program in affected areas of bauxite explotation in Los Pijiguaos' mountain (Bolívar State). Composition and richness of plant species were evaluated in the natural forest and three zones with different rehabilitation times: 12, 7, and 5 years; sampling was done from May to September 2002. Six 50-m^2 plots were located in each zone to estimate species importance in arboreus-arbustive and herbaceous layers; other variables were also taken, such as leaf type and shape, canopy height, litter depth, and growth form. The Shannon diversity and Sorensen similarity indexes were calculated. Species richness was 60, 30, 27, and 26 in the arboreus-arbustive layer, and 39, 23, 20, and 21 in the herbaceus layer for natural forest, rehabilitation years 12, 7, and 5, respectively. Diversity index values were 3.14, 2.41, 2.16 and 2.60 in the arboreus-arbustive layer, and 2.98, 2.07, 1.98, 2.54, and in the herbaceus layer for natural forest, rehabilitation years 12, 7, and 5, respectively. Similarity between rehabilited zones was 63-72%. Similarity of natural forest sites was 47%, 44%, and 51% with rehabilitation years 12, 7, and 5, respectively. Data analysis suggests the rehabilitation process shows no revelant effect, and time and proximity to the natural forest are the most important influences in these areas.

Keywords: vegetation, tropical forest, rehabilitation, bauxite mine, Venezuela.

Resilience and the restoration potential of natural ecosystems degraded by fire -case study from Morocco-

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The study has for objectives: 1) to study the structures and architectures of the forest ecosystems devastated by wild fires in the Chefchaouen area, Morocco, in order to determine the most resistant and resilient ones 2) To suggest an action plan for restoring the burnt zones and aiming their sustainable management. The methodology followed to carry out this study is the establishment of architectural and structural profiles. For the floristic composition, we applied the phyto-sociological method Zuricho-montpellieraine of BRAUN-BLANQUET. It was observed that the manmade pines forest and the ecosystems dominated by Cistes and by Erica arborea are the most sensitive to fires. The balanced ecosystems, in floristic composition, structure and architecture, are the most resistant and resilient to fires. In conclusion, the restoration of t he burnt clump can be done only by supporting the installation of the various layers (herbaceous, shrubby and raised) and by respecting the natural distribution of the endemic forest species.

Keywords: forest ecosystems, fires, restoration, Morocco.

A knowledge-based factor model to prioritize areas for post-fire restoration

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Large areas of Mediterranean drylands are subject to land degradation due to anthropogenic and climate synergies and also to high fire occurrence due to climatic and land use conditions. The most vulnerable areas are at risk of suffering degradation feedbacks. We aimed at developing an operational framework for the identification of the areas most vulnerable to wildfires so that they can be prioritized in prevention and/or restoration activities. We elaborated a synthetic indicator and a GIS-based application to assess wildland vulnerability to wildfires in Mediterranean landscapes by combining community-level intrinsic factors, related to vegetation resilience (potential regeneration capacity), and site-level abiotic factors related to soil degradation potential. We estimated the potential regeneration capacity according to the forest stand age and the relative abundance of resprouter species. To derive soil degradation potential we considered factors limiting spontaneous plant recovery after wildfires, such as the intensity of the dry period, and erosion potential. Using the available cartography, we applied this methodology at the regional scale to evaluate the susceptibility to post-fire deterioration of the wildland surface in the Valencia Region, eastern Spain, and to establish areas for priority actions.

Keywords: Forest planning, GIS application, land degradation, plant recovery, post-fire management.

Use of the macroinvertebrate community to assess habitat degradation in the upper watershed of the Henares River (Central Spain): proposals for habitat restoration

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Channel incision is an important cause of habitat degradation in fluvial ecosystems. It produces modifications in channel morphology, water quality, and substrate composition. These changes may cause alterations in the in-stream communities. Part of the upper watershed of the Henares River is affected by habitat degradation. The aim of this study was to assess the effects of channel incision in the habitat and in the structure of the macroinvertebrate community. Two study sites were selected: site 1 was located in a relatively well-preserved reach, and site 2 was in a reach affected by channel incision. In each site several physico-chemical parameters were measured from May 02 to July 02, habitat properties were assessed in May 02, and five samples of benthic macroinvertebrates were collected with a Hess sampler in June 02. Macroinvertebrate community was assessed using several density, richness, diversity and biological quality metrics. The comparison of physico-chemical properties between sites showed higher dissolved oxygen concentration, conductivity, pH and chloride concentrations, and a lower thermal stability at site 2 than at site 1. Additionally, this site showed a high frequency of benthic fine mineral sediment (98%) and macrophytes (60.4%). The total density of macroinvertebrates and some specific groups (Oligochaeta, Chironomidae and *Ephemerella* sp.) were higher at site 2, whereas Planariidae density, Plecoptera richness and biological quality were lower at that site. Total and EPT richness tended to be higher at site 1. It is concluded that channel incision caused modifications in physico-chemical, habitat and macroinvertebrate community properties. In order to improve the macroinvertebrate habitat, several proposals are put forward for stream restoration.

Keywords: stream macroinvertebrates, habitat degradation, channel incision, stream restoration.

REDOTE, the Spanish Long Term Ecological Research Network, as a tool for the assessment of the success of restoration activities

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The main objective of ecological restoration is to return degraded ecosystems to their original natural conditions. The International Long Term Ecological Research Network (ILTER) was based on the assumption that long-term studies are necessary for a broader understanding of ecological phenomena. Long-term studies can play a very important role in restoration as i) they provide reference information to define the goals of the restoration projects and ii) they allow to assess the success of restoration activities. Unfortunately, long-term monitoring of restoration projects is rare. REDOTE (www.redote.org) is an initiative to organise a Spanish LTER Network based on monitoring stations in selected terrestrial, fluvial, coastal and marine ecosystems. REDOTE is aimed at optimising existing human and economic resources to create a reliable infrastructure of research, and is coordinated with the European ALTERnet network of excellence, which shares these aims., Although the information centralized in REDOTE's database is expected to help in the detection of trends and effects of global change in a number of pristine ecosystems, it can also be used as a reference for restoration projects.

Keywords: Restoration activities, monitoring, Spanish LTER Network, global change.

Ecophysiological monitoring of seaweeds used in a seabottom restoration project in the Seto Inland Sea (Japan)

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During the past 100 years natural coastal habitats of the Seto Inland Sea have been reduced to nearly the half due to land reclamation and the reconstruction of the seashore. Artificial vertical structures with uniform surface textures, as man-made walls observed in harbours, provide poor habitats for marine organisms, and due to this in order to achieve sustainable coastal development, macroalgal beds restoration is essential for the conservation of the coastal environment. The importance of macroalgal beds is relevant, specially in enclosed seawater areas, as they serve as nurseries for many fish species, food for many herbivores, and function as purifyers of polluted seawater. Seaweed beds restoration projects should require scientific monitoring programs, in order to assess the successful acclimation of the macroalgae to the new conditions under an ecophysiological point of view. A monitoring program has been followed on *Ecklonia cava*, a kelp used for the restoration of man-made walls at Saigasaki Coast, Wakayama Prefecture (Japan). Besides the restoration techniques (transplantation of adult sporophytes, release of spores and in lab fertilized substrates) used to settle *E. cava* beds at the study site, we present data of the ecophysiological monitoring, including *in situ* photosynthetic measurements performed with an underwater pulse amplitude modulated fluorometer and growth rates.

Keywords: coastal degradation, ecophysiological monitoring, macroalgal beds, seabottom restoration.

Bases for the correction of tensions in the interaction natural connectivity-human infrastructures

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Vectorial phenomena supporting spatially relevant ecological processes of the landscape are decisive. This is the case of energy flows, movement of water and materials and biological migrations. The importance of those processes affects the functionality of the territory. In order to protect the connections maintaining the functionality of the 'territorial meshes', it is necessary to consider the relationship 'plan-

ning and ecology'. Thus for instance, the infrastructures must avoid to generate interferences in the ecological connection. The projected enlargement of the Iberian roads network invites us to systematically analyze these circumstances. The objective of a project currently developing is avoid the overlapping the planned network of infrastructures with the natural ecological network and cultural rural network. Then we define and characterize the 'tension points' between the ecological and roads networks. Hence, we establish objective indices that measure the degree of compatibility between infrastructures with the ecological processes. Also, we classified environmental techniques of infrastructures and developed criteria to improve the planning, design and execution of projects, adding criteria of integration in the landscape. Our study concluded that its application could increases in price the cost of infrastructures, although the maintenance of the natural networks is an important key for the human economy.

Keywords: Territorial meshes, natural ecological network, cultural rural network, tension points, objective indices.

Salt-marsh restoration in Deba river estuary (Gipuzkoa, Basque Country)

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In the Basque Country 80% of the salt-marshes were transformed by different anpropic land uses (agriculture, urban sites, infraestructures etc). Nowadays, after the approval of the "Sectorial Territorial Plan of wetlands", by the Basque Government, these sites are starting to be restored to the original situation. The current study is located in the Deba river estuary (Gipuzkoa) and was started in October 2003 when the first channels were opened. In October 2004, after doing the soil characterisation, halophytic plants were introduced. This study shows the results of the first year soil edaphic condition and plant monitoring.

Keywords: soil edaphic, halophytic plants, Deba river estuary, land uses.

Reconverting a riverbank from agricultural area to Natural Habitat: I. Soil classification and salinity mapping for determining the riparian restoration potential

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In the past, irrigated agriculture has occupied areas of ecological values such as the riverbanks. Improper soil and irrigation management of those areas resulted in soil compaction and salinization, reducing soil quality, conditioning the agricultural productivity, degrading the quality of water resources and decreasing the diversity of wildlife. "Soto de los Tetones" (Riverbank of Tetones) is an example of a riverbank that underwent irrigated agricultural development with significant soil degradation. It occupies an area of 110.4 ha in the flooding plain of the right bank of the Ebro River in Tudela (Navarre, Spain). It has been under cultivation since the 1970s mainly with rice because of its saline condition. In 1998 the Government of Navarre declared it as "Enclave Natural", a local legal form of environmental protection developed to preserve and improve the ecological values of any area while allowing properly-managed human activities. Planning restoration of this area requires knowing the soils' characteristics and limitations. The objective of this paper is to characterize the soils and salinity conditions of this area for determining its restoration potential. Nineteen profiles were described across the entire area and 95 soil samples were collected for chemical and physical characterization in laboratory. Soil salinity was estimated using an electromagnetic-induction sensor (EM38) calibrated with classical sampling techniques for specific soil type and water-conditions. The salinity of the 35-ha presumably-salt-affected area was analyzed by reading the bulk soil electrical conductivity (ECa) with the EM38 sensor at 558 locations and by measuring the electrical conductivity of the saturation extract (ECe) of soil samples taken at 30 of those locations. The regression of ECe on EM readings predicted ECe with $R^2 > 0.92$ for the 0-100 cm soil-depth. The delineated soil classification map and soil salinity map identified the major soil limiting factors of the study area and provided valuable information for determining the potential of the site to support particular species and plant communities.

Keywords: riverbank reclamation, riparian ecosystem, natural habitat, soil salinity, electromagnetic sensor, soil limiting factors.

Habitat restoration strategies for the endangered population of Lesser Grey Shrike (*Lanius minor*) in Aragón (NE Spain)

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Iberian pseudosteppe habitats have undergone drastic declines in the last decades due to agriculture intensification, with concomitant declines in populations of steppe-land birds. A case of special concern are the two last Iberian populations of lesser grey shrike (*Lanius minor*), which are considered on the brink of extinction. We studied the habitat selection of the critically endangered population of Aragón (with only 6 breeding pairs), where traditional fallow systems for cereals and field margins have been recently replaced by irrigated and biocide treated crops. Breeding lesser grey shrikes preferred to forage on fallow land, grassy field margins, and crops after sheep grazing, while rejected irrigated cereal and fruit tree crops. This selectivity seemed to be due mostly to prey availability. In addition, behavioural constraints seem to restrict the use of some of the new habitats created by man through agricultural intensification. This work confirms the need to restore the species habitat, recovering the traditional low intensity farming, especially by promoting fallowing and increasing the field margins. Extensive sheep grazing and low biocide treatments are both recommended. Restoration of critical pseudosteppe habitats will require substantial future effort to ensure the recovery and long term viability of the Iberian lesser grey shrike populations as well as of other steppe bird species.

Keywords: Pseudosteppe bird populations, habitat selection, restoration, lesser grey shrike.

A large scale outdoor laboratory in restoration ecology

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Reclamation of severely degraded land aims to overcome factors that restrict ecosystem development, encourage vegetation succession and restore ecosystem functions. A large-scale, long-term experiment was established in 1999-2000 on a barren, desertified area in Iceland to test the effectiveness of different methods for restoring ecosystem structure and function. The experiment consists of forty plots or experimental units, each being 100 x 100 m (1 ha), with > 50 m wide buffer zones between plots. Nine different reclamation-afforestation treatments and untreated control are compared in this experiment and these replicated four times. The reclamation treatments have resulted in a steady increase in vegetation cover and after five years it was over 70% in some treatments compared with 5% in untreated controls. In 2003, treated plots had slightly lower pH and higher soil carbon than control plots, and new plant and arthropod species were found in the reclamation plots, especially those plots that were only treated with mineral fertilizer without artificial seeding. This indicates that the reclamation treatments are affecting ecosystem properties and effectively overcoming factors that limit succession. The rigorous experimental setup in this study gives an opportunity to answer some fundamental questions regarding the effects of different reclamation treatments on ecosystem development. The experiment can thus serve as an outdoor laboratory in restoration ecology. A new phase of the project begins in 2005, with increased emphasis on factors such as nutrient cycling, hydrology, surface stability, soil development and colonization dynamics of individual plant species.

Keywords: Desertified area, Iceland, reclamation, succession.

Uncertainty of wetland restoration in La Mancha húmeda (Central Spain)

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La Mancha Húmeda [wet La Mancha] was declared Biosphere Reserve by UNESCO in 1980. Wetlands covered 25,000 ha in the area around 1970, which were essential for birds migrating between Europe and Africa. Since 1970 approx. many man-made processes have been taking place in La Mancha Húmeda, such as 1st) channelisation of flooding streams in alluvial plains, 2nd) wetland dessication, 3rd) heavy overexploitation of aquifers on which wetland ecological performance was dependent, and 4th) heavy impairing of water quality. All these threats have seriously degraded wetlands, thereby reducing their numbers to one fourth by the early XXI century. On the other hand, some measures have been carried out to tackle that degradation, such as many scientific studies and several public efforts with limited success to

attempt wetland restoration. Public opinion in La Mancha Húmeda values wetlands much more as emotional landscapes than by their ecological services, without keeping in mind that wetlands depend upon water resources that are strongly demanded by irrigation. Current state of La Mancha Húmeda wetlands is hence at a cross-road between the maintenance of irrigation as a publicly-funded economic activity that arrests wetland restoration and some Objectives of the European Water Framework Directive, which are aimed at preventing environmental degradation and preserving and even improving the ecological state of aquatic ecosystems. Therefore, there is a remarkable uncertainty of achieving those goals, which obviously must be included in a sustainable management plan of the natural resources of the territory in which aquatic ecosystems of La Mancha Húmeda are located.

Keywords: Environmental degradation, international wetlands, public opinion, Water Framework Directive.

Restoration Project of a Wetland of Community Importance (SCI) in NW Spain

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The studies which have led to the writing of the restoration project of the Site of Community Importance "Gándaras de Budiño" (NW Spain), a wetland of 727 hectares, are exposed. The evolution of the site has been analysed through aerial photographs, and hydrogeologic surveys have been carried out to interpret its present-day behaviour. The composition and size of the sediments has been analysed. Hydrological alterations and processes of accelerated sedimentation because of erosion have been documented. These alterations are caused by 1) the quarrying of granite and kaolin around the wetland, 2) construction of draining channels for cultivation, 3) the construction of two industrial estates and a motorway on the wetland and over the areas of recharge of the aquifer that feeds it, and 4) the dredging of the Louro river. These alterations have brought about radical changes which have affected its surface area and appeareance, its habitats and the composition of the vegetal communities it holds. These alterations have reduced significantly the conservation value of the area. The high degree of transformation of the wetland and surrounding areas make it impossible to undertake a complete ecological restoration. Unless urgent conservation measures are taken, the wetland will continue to loose the natural values for which it has been protected. The restoration project will be undertaken by the Confederación Hidrográfica del Norte (Spanish Ministry for the Environment).

Keywords: wetland, hydrological alterations, accelerated sedimentation processes, restoration.

Seedling growth and physiological responses to edge gradients as a basis for guiding restoration approaches in fragmented landscapes

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In fragmented landscapes, successful forest regeneration depends largely on the capacity of seedlings to establish across edge gradients. Despite diminishing land use pressures in many fragmented landscapes, severe alteration of habitat and microclimate conditions may create barriers to successful regeneration and necessitate active restoration. This study examined establishment potential of plant species with contrasting life history traits (*Quercus acutifolia, Q. castanea, Pinus oaxacana, Dodonea viscosa, and Rhus virens)* across edge gradients in fragmented montane oak forests in southern Mexico. Seedlings transplanted into edge microsites were assessed for growth (height, leaf area, above- and below-ground biomass, rooting depth, mortality) and physiological (pre-dawn moisture potential, nutrient uptake and resorption efficiency, leaf phenology) responses. Additionally, microclimate (temperature, PAR, soil moisture) across edge gradients was measured. Species' adaptations to moisture stress and associated tradeoffs between water and nutrient acquisition, were primary factors explaining performance differences. Edge environments favored establishment of *D. viscosa*, with its rapid growth and leaf turnover rates, high nutrient uptake and resorption efficiency, and high pre-dawn water potentials. Conversely, oak seedlings, with their more conservative growth strategies, exhibited high moisture stress and mortality, especially during severe drought. Pine and *R. virens* showed intermediate growth performance, attributed to their adaptive strategies to drought and relatively fast growth rates. Oak regeneration appears to be constrained by extreme microclimate conditions, especially with increasing frequency and duration of

drought. Restoration efforts in fragmented landscapes may facilitate forest reestablishment by protecting or actively establishing species associations having ecophysiological characteristics that enhance microsite conditions for natural regeneration.

Keywords: edge gradients, forest regeneration, southern Mexico.

Analysis of woody species used in the restoration of semiarid mine slopes of Val de Ariño (Teruel)

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In the restoration of surface mining slopes of Val de Ariño (Teruel) a set of shrub and tree authoctonus species were selected (Pinus halepensis, Quercus ilex ssp bellota, Quercus coccifera, Pistacea lentiscus, Juniperus phoenicea). One-year-old seedlings were planted in holes (40 x 40 x 40 cm) in the minesoil of south-facing slopes during 1995. 10-years afterwards, its growth is analyzed measuring height, diameter, survival and soil recovery in 90 plants per specie.

Keywords: authoctonus species, restoration, Teruel.

Proposal and verification of an enviromental flow regime in the Trevelez river (Granada)

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The river Trevélez is one of the main fluvial arteries that drains trough the natural park of Sierra Nevada in Granada (South Spain), now it is affected by several disturbances, including a hydroelectric station project. Therefore an investigation project has been developed to design an enviromental flow regime with the purpose of diminishing the alterations that will be produced in the system when regulating their flow. Previous works of our group in several sections of this river show the importance of the populations of trouts, from the biological point of view and by its recreational interest like fishing resource; due to this it was decided to choose between the wide range of methodologies that can be applied to the calculation of enviromental flow, the one focused to optimize the habitat of trouts populations. We used IFIM methodology and trout preference curves for the calculation of the flow, A topographical survey was made along six cross sections because of the geomorphological complexity that presents the channel from almost the head of the basin to as lowest as 900 m. of altitude, in each section topographical surveys were made to be able to use the model in 2 dimensions (River 2D) developed in the University of Alberta (Steffler et al., 2.000), in Canada. In addition a hydrologic study was made that served to characterize the natural regime and imitating it, in the proposed environmental regime. Several minimum environmental flow for different stages of trout were obtained and, several environmental regimes for years dry, normal and humid have been set out and proposed to maintain intranual variability characteristic of the river, hoping that the maintenance of these flows in the river is able to maintain the structural complexity and the feasibility of the system, after the system was altered by the proposed regulation.

Keywords: Enviromental flow, preference curves, hydrological regime.

Restoration in the Mojave Desert, California USA: a retrospective look at large-scale natural and facilitated restoration along the Los Angeles Aqueducts

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The Bureau of Land Management (BLM) is undertaking landscape-level restoration projects to reduce fragmentation and improve upland habitat quality in the western Mojave Desert for federally and State of California listed threatened and endangered species such as desert tortoise (*Gopherus agassizi*) and Mohave ground squirrel (*Spermophilus mohavensis*). Current projects at this scale are unprecedented. Existing information about human intervention n ecological processes that efficiently facilitate restoration are poorly understood and not described with an ecological model. To address gaps in knowledge about restoring Mojave Desert vegetation, scientists at the US Geological Survey and the BLM are studying the

phenomena of 223-mile long and 137-mile long construction projects for the two Los Angeles Aqueducts across BLM lands in Kern County, CA. Contemporary photographs of the first aqueduct, completed in 1913, set a baseline for vegetation cover and ground disturbance. Facilitated restoration of disturbed land along the 137-mile Second Los Angeles Aqueduct, completed in 1970, was the first large linear restoration project ever documented for the Mojave Desert bioregion. Ground-based and aerial re-photography taken in the intervening years from identical sites provides models of transition states of vegetation development. Focal species are Joshua trees (*Yucca brevifolia*) and creosotebush (*Larrea tridentata*), major species for providing wildlife habitat and so-called "fertility islands". From these diverse sources and focal species, a conceptual model and a stochastic mathematical model for Mojave Desert vegetation growth, development, and replacement are evolving.

Keywords: Mojave Desert, landscape restoration, linear disturbance.

Integrated environmental recuperation plan of the Lafarge-Asland quarry located in the municipality of Yepes (Spain)

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The integral restoration project of the quarry that the Lafarge-Asland group owns in the municipality of Yepes, located in the geological limestone formation called *Mesa de Ocaña*, was elaborated in year 2004 by the Environment Consultancy firm Plegadis S.L. after the previous research work on plant formations in the quarry done by the University of Castilla-La Mancha, and its execution is planned to begin soon this year. Lafarge-Asland's objective, when developing a project with these characteristics, is to create an integrated restoration model where, not only ecological restoration actions on a deteriorated environment after anthropic aggression are included, but also where, through the participation of all the local agents involved, a new use of the territory is considered – one that will endow it with assets supplementary to the existence of mineral resources to be exploited. Public use, environmental education and hunting activities with a social vocation are other variables that have been worked on in order to develop this integrated model. But the Lafarge-Asland group knows very well how important the participation of specialists and researchers is in the design of the processes of plant recuperation, when restoration is focused on the regeneration of biodiversity. This is the reason why, in the framework of an on-going collaboration programme with the Environmental Sciences Faculty of the University of Castilla-La Mancha, in particular with its Botany Department, scientific research works have been incorporated into this integrated restoration model, thus creating a series of rates that will allow the monitoring of the environmental evolution process in the quarry, on one side, and, on the other, that will become a reference when the time comes to design the environmental restoration of the quarry taking as a basis the reinforcement of these evolution processes. The implementation of the results from academic research will allow establishing an ecological restoration model on which biodiversity and the recuperation of altered spaces to recreate the original natural environment will be given priority. The implementation and contagion of this mining restoration model on to other promoters will help revert to public use and research and environmental sensitizing activities a great part of our national territory presently altered because of the mining activity

Keywords: geological limestone formation, Yepes (Spain), environmental evolution.

Restoration of degraded forests and its benefits for sustainable rural development: a case in the Chaco region (Argentina)

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The *vinal* (*Prosopis ruscifolia*), an extremely aggressive woody invader, affects grazing land and abandoned farm lands, but it also presents great potential as a wood producer, and has a fruit with a high nutritional value. The traditional methods for eradicating it are expensive and inefficient. A model for the restoration and the integral management of degraded forests, and its benefits to local development, was analyzed in Ibarreta, Formosa. The model has 10 yearly modules (3 hectares per plot), with interventions in the forests every 5 years, and a projection over 20 years. Silvicultural tasks are performed, including pruning, selective thinning, and enrichment and protection of native woody saplings. One hundred percent of the wood is used (carbon- coal, firewood, posts, beehives, and lumber milling), progressively improving its quality, and the health of the forest, obtaining approximately 75 tons/year. The closures allow for the manipulation of cattle, and the restoration of the herbaceous stratus (growing from 0.12 UG/ha to 1.2 UG/ha). The

fruit production of the *vina*l and other *Prosopis* is used for human and animal alimentation (1,200 Kg./ha). Moreover, apiculture is practiced in the forest, taking advantage of the extended flowering, and natural thermal regulation. The economic balance for all the products obtained by the differentiated management is analyzed over a 20 year period, to determine the impact on the productive domestic economies. The model is being implemented by 60 families, which indicates that the technical aspects and the economic and financial viability are fitted for the local environmental and socio cultural conditions.

Keywords: Chaco region, economy, local development, restoration, secondary forest.

Restoration of sub-surface and surface water through fish farming in wetlands of East Africa

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Major towns and cities in East Africa are surrounded by extensive wetlands, which are a source of water for domestic use for the urban poor and those without access to established water supply systems. There is a lot of sand harvesting, clay mining as well as human settlement as a result of high population in these peri-urban areas resulting in serious degradation. There are huge pits left behind that become a breeding area for vermin. Planting of eucalyptus trees has aggravated the situation, as these trees have succeeded in decimating many streams and springs thus people are forced to travel much longer distances to source water. This paper reports on studies carried out in 2004/2005 under IUCEA/ SIDA (Victoria Research Initiative) in Wakiso and Kampala in Uganda, Gucha, Nyamira and Kisii in Kenya and Kayenze, Luchelele and Tarime in Tanzania. The study underscores fish farming and integrated agriculture- aquaculture as options in restoring these wetlands, ensuring a clean source of water for domestic use, providing the much needed protein in diet, as well as income and employment. Aquaculture also sustains ground and underground water sources. Current experiments indicate that farmers in the region have embraced integrated aquaculture as a means of intensifying food production. The paper reports their challenges, success and the positive impact on water availability. Results from two show aquaculture (90%) to be the best economic activity to practice in wetlands, 9% thought horticulture could offer better opportunities while 1% was contemplating engaging in tree planting. Respondents expressed what they thought were threats/problems of wetlands. These included; seasonal flooding, habitats for predators to their fish and other farm produce. Inaccessibility to some wetlands in Kisii Nyamira and Gucha districts were cited as problems in utilizing the wetlands, while planting of eucalyptus trees in catchments has led to the death of some wetlands.

Keywords: Sustainable water use, wetland restoration, integrated aquaculture-agriculture, East Africa.

Restoration of broad-leaved forest vegetation of Middle Volga: an ecological aspect

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A vegetation survey was initiated for the aims of upland forest restoration in the Volga basin of Nizhny Novgorod region, Russia. Potential nature vegetation varies there from lime-oak forests (*Quercus robur* and *Tilia cordata*) to meadow steppes depending on a soil type. Described area was highly wooded in the past, but oak decline and total vegetation fragmentation are significant at present. Nevertheless, oak often prevails in the periphery of forest tracts. Investigation of vegetation correlation structure was made to describe regional sociological-ecological species groups and to elucidate a role of rare and endangered species in plant communities. A presence of solid nemoral group with *Pulmonaria obscura* as a central species using correlation and cluster analysis was discovered. Nature habitats of endangered species were surveyed and described in terms of Ellenberg indicator values. The obtained data were used to assess reintroduction possibility for the restored area. The species under consideration include eastern European floristic elements such as *Laser trilobium*, *Bupleurum aureum* and *Pulmonaria angustifolia*, as well as Mediterranean and middle-European ones (*Genista germanica*). These species are endangered due to easy distinction by human impact and habitat loss. Many of floristically distinctive species, used in vegetation zoning of the region are also under threat. Ex-situ conservation measures have been attempted for some species for later restoration of floristically depauperate vegetation.

Keywords: Broad-leaved forest, restoration, vegetation structure, Ellenberg indicator values.

Reclamation of degraded soils from a gravel pit using organic amendment

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Industrial development creates degraded sites -like landfills, gravel pits, quarries, etc.- with uncovered soils that must be reclaimed to minimize the environmental impacts of these activities. Leaving soil restoration to ecological succession takes a lot of time to recover native plants and dynamics of the original ecosystem, so it is necessary the development of tools to help natural restoration processes of degraded lands. Organic amendments (sewage sludges) can be used to improve physical and chemical properties of these degraded soils supplying organic matter and nutrients. The application must be carried out in controlled conditions according to the EU legislation in order to avoid the potential risk of soil pollution. The aim of this paper is focused in the evaluation of organic amendments application to improve the edaphic properties of degraded soils from a gravel pit in order to speed up the establishment of surrounding native vegetation. A field experiment was carried out with a randomized complete blocks design in a degraded soil located in a gravel pit in Talamanca de Jarama (Central Spain). Two different treated sewage sludge (composted with prunning wastes and treated by thermal drying) and one sludge from gravel processing (washing of geologic material extracted) have been applied as soil amendment. Spanish climate conditions are especially suitable for the rapid mineralization of organic residues, so their application to degraded soils constitutes a favourable sewage sludge recycling system, improving the establishment of herbaceous native cover, which plays an important role as starter in natural processes of ecological succession.

Keywords: reclamation, organic amendments, degraded soils, native plants.

Research about the present conditions and improvement of pineforest that is fixing the sand dunes in Guardamar del Segura (Alicante, Spain)

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This work seeks to confirm and evaluate the problems that are spoiling the pineforest that is fixing the sand dunes on Guardamar del Segura (Alicante). This pineforest is essential and must stay on the dunes for the protection of the town and the ecosystem installed there 100 years ago. Earlier research points out that the pineforest has no auto-regeneration capacity of itself, and its worst problem is sea spray damage to the pine needles. To analyse the health of the pineforest, five line transects were sectioned-off perpendicular to the coastline and eleven sample plots sized 25 x 25 m were also created. Stand density, tree height, trunk and crown diameters, crown height, pathogens and percentage of spray damage to pine crowns, were measured within the sample plots and line transects. We discovered that the sea spray has a bigger effect on the stone pine (*Pinus pinea* L.) (38'29%) than the Aleppo pine (*Pinus halepensis* Mill.) (30'05%). The mean of arithmetical diameters (17'14 cm), mean of height (4'43 m) and stand basal area (7'93 m^2/ha) values, suggest that pines are surviving on the dunes, but with a lot of trouble (low levels of nutrients and water, etc.). Many solutions to avoid or reduce the spray damage were considered and analysed. So, we advise to establish forest windbreaks composed of 50% Spanish broom (*Spartium junceum* L.) and 50% bridal broom (*Retama monosperma* (L.) Boiss.). Looking forward, this work could be combined with many other studies about the natural pineforest regeneration.

Keywords: Desertification, sand dunes, sand dunes fixation, acid rain, windbreaks.

The role of natural wetlands and plant-covered channels in reducing wastewater impact on saline lakes from "La Mancha" (Central Spain). The case of Laguna de Manjavacas

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Wetlands from specific areas of La Mancha plateau, a very flat region located in Central Spain, are protected by several international treaties and national or regional laws. Many of these are associated to saline lakes from endorheic origin, such as Laguna de Manjavacas (Cuenca, Castilla – La Mancha, Spain). In spite of these legal protections some lakes received or still receive wastewater inputs from nearby towns, although implementation of treatment plants is nowadays planned. After flowing for 8 Km through a

plant-covered channel, wastewaters from the village of Mota del Cuervo (5500 inhabitants) flow into the saline Laguna de Manjavacas through a very shallow wetland totally covered by a helophytic community dominated by *Phragmites australis*. Although the lake shows a high trophic level, strong organic and inorganic nutrient retention and transformation within the mentioned channel and wetland prevents the collapse of the system that otherwise would occur due to the very low water exchange and the extraordinarily high organic and nutrient loads that the lake would receive without this purification effect. Up to 98% of the particulate organic load, 81% of N-NH_4^+ and 80% of total P from sewage is retained or transformed within the 8 Km channel path and the *Phragmites* wetland, reducing the eutrophication impact. Results from previous studies are compared with those obtained from a monitoring program nowadays under progress sponsored by the Consejeria de Medio Ambiente from Castilla – La Mancha.

Keywords: Water purification in wetlands, saline lake.

Arbuscular mycorrhizae (AM) influence plant growth and establishment in two semi-arid ecosystems in central Mexico

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Semi-arid ecosystems are characterized by low fertility soils and scarce precipitation, limiting plant growth and establishment; consequently, the presence of arbuscular mycorrhizae (AM) could be advantageous for xeric plants. This study focused on the mycorrhizal status of xeric plants and the effect of AM on seedling performance in two high degraded semi-arid regions in central Mexico: the Mezquital and the Tehuacán-Cuicatlán Valleys. Field and greenhouse assays were assessed. Of 60 plant species sampled in the field, 55 were found to be mycorrhizal; we report AM for the first time in 37 species, of which 30 are endemic to Mexico. In a "field simulated" greenhouse experiment, we analyzed the effect of AM colonization and phosphorus fertilization on the growth (length and dry biomasse) of seedlings of nine woody legume species and one cactus: *Acacia shaffneri*, *Mimosa* spp. and *Prosopis laevigata*, and *Opuntia streptacantha*. Although our results showed a wide range of responses, general trends were determined: mycorrhizal seedlings grew more, and had significantly higher shoot phosphorus content than non-mycorrhizal seedlings; non-mycorrhizal seedlings had a lower shoot dry weight ratio and a higher root weight ratio than mycorrhizal seedlings. Unexpectedly, benomyl significantly reduced the number of root nitrogen-fixing nodules in all legume species. AM fungal morpho-species reported belong to genera *Acaulospora*, *Gigaspora*, *Glomus*, *Sclerocystis* and *Scutellospora*. This study point out the relevance of AM for xeric plant establishment and for seedling growth. Therefore, there is no doubt that mycorrhizae are important in both plant establishment and ecological restoration in semi-arid ecosystems.

Keywords: arbuscular mycorrhizae, restoration, seedling growth, semi-arid ecosystem.

Alternatives to the post-mining landscape in La Rioja (Spain)

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The long tradition of the mining working in La Rioja (we found abundant important archaeological remains and some coal mining working opened at the end of the 19th century), the limited planning view of the mining working and the shortage collective conscience made that we have 533 remains of mining activities. Now, the Autonomous Community of La Rioja is elaborating the Mining Director Plan that contains a program about the restoration of these post-mining landscapes. This paper tries to offer a first analysis and approximation to the global problem, and we try to identify in which cases the restoration is necessary and what type of restoration need: reparation a damage ecosystems, creation of a new ecosystem of the same kind to replace one that was entirely removed, creation of another kind of regional ecosystems to replace one which was removed from a landscape that became irreversibly altered, creation of a replacement ecosystem where an altered environment can no longer support any previously occurring type of a regional ecosystems and creation of a replacement ecosystem, change the land use to urban development use, or industrial use, or cultural use or use some these post-mining to ordinate waste's management. We start from a description of the regional landscape and the inventory of the abandoned mining working.

Keywords: Post-mining landscape; land use changes; reparation; rehabilitation; restoration; La Rioja; Spain.

Restoration process assessment of the Guadiamar Green Corridor, analyzing ground beetles fauna (Coleoptera: Carabidae)

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In 1998, a breach in the Aznalcóllar Mines retaining wall led to toxic sludge pouring out into the Guadiamar river basin. After the disaster, a series of emergency measures were taken in order to clean up and remove the sludge and a Restoration Plan (PICOVER) was instigated for the integral management of the river basin. We worked on the aforementioned Plan assessing the ecological impact of the accident on populations of edaphic Coleoptera because soil macrofauna tends to be highly affected by environmental disturbances. This faunistic poverty became increasingly evident closer to the accident site. Results also suggested that the affected areas could undergo a process of rehabilitation because several potential recolonizing species have been identified. After six years, in 2004, we tried to establish if the faunistic recolonization observed in the Green Corridor involved a regeneration process, which would be shown not only as an increasing diversity but also as the presence of stenotopic - no generalist- species. In order to answer these questions, we decided to concentrate upon the Carabidae family, widely considered as an effective biological indicador. Results revealed a clear recolonization process. The presence of C. *lusitanicus* and C. *melancholicus* is particularly noticeable, whose MIB values are close to the highest estimated values for carabids that inhabit the south of the Iberian Peninsula. Regarding the extent of wing-development of *Calathus granatensis,* a polymorphic species, we observed that about the 75% of the specimens collected were apterous. This percentage reaches 98% in a non-disturbed oak-meadow adjacent to the research area and, yet, the only two specimens founded in the PICOVER sampling were to be macropterous. In summary, changes in Carabid fauna enable us to conclude an incipient restoration process that, with a high probability, will become more evident in the future.

Keywords: Aznalcóllar Mines, toxic sludge, Guadiamar River, Coleoptera

Methods for the study of vegetation in the adaptive restoration of an agricultural estate in Doñana National Park (SW Spain)

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The «Doñana 2005» project to restore the marshes of Doñana National Park is subjected to an extensive scientific evaluation, in order to assess the success of the restoration in terms of the ecological objectives. In restoration action number 6 (Caracoles Estate-Travieso Channel) more than 2,600 ha of marshes, transformed decades ago into arable farmland, is being restored by removal of dykes and drainage ditches. The restoration is being carried out with an adaptive approach, placing great emphasis on the methodology used to monitor its success. The steps followed to design the methodology for monitoring vegetation changes have been 1) study of the vegetation and seedbank present before the restoration begins; 2) selection of reference sites nearby and unaffected by agriculture; 3) prediction analysis of flooding regime following restoration; 4) study of time-series of geo-referenced images and analysis of the vegetation index (NDVI) of the cultivated fields (historical reconstruction). The results obtained allowed us to identify the need to design a one-dimensional mesh of nested sampling points (3 levels, with distances of 1000, 250 and 62.5 m between points), with 270 long-term sampling points in the estate and 82 points in the reference sites. In each point, different environmental parameters will be measured, as well as sampling vegetation and the seed bank. The results will help to design modifications of the restoration actions, as well as management of the area restored.

Keywords: adaptive restoration, vegetation changes, marshes, Doñana National Park.

Importance of a multidisciplinary approach to the ecological restoration of gypsum quarry areas in a semiarid region of Spain (Sorbas, Almeria)

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The gypsum quarry "Los Yesares" in Sorbas (Almeria, Spain) (Iberplaco, S.A.) is the largest of its kind in Europe with an affected area of 1 Km^2. Besides a negative impact on the landscape, its exploitation generates "steriles" which suffer the intense effects of erosion, in a region whose semiarid climate complicates any restoration strategy. We have evaluated several ways of approaching the restoration of the degraded ecosystems of this area. The complexity of the task at hand and the challenge it poses, especially since the area to be restored is next to a "protected landscape" as defined by European legislation, requires that the problem be tackled on several fronts. Herein, we report the three main approaches (geological, edaphic and ecological) explored over a 4-year period. The main actions so far have been: 1) controlling erosion using systems designed especially for N-facing landfills and for landfills emptying their deposits onto the only wetland and lagoon created in this landscape; 2) amending residual steriles and fines by mixing with MSW composts; 3) using soil from the exploitation front to cover the landfills; 4) managing the landfill vegetation by promoting the growth of several endemic plants using the available seed bank; and 5) revegetating slopes with native species to minimise negative aesthetic impacts. These actions involve trials in both field and controlled conditions, as well as their detailed monitoring.

Keywords: gypsum soils, erosion, quarry restoration, revegetation, endemisms, organic amendments.

Restoration of *Quercus pyrenaica* Willd. forests using pioneer shrubs as nurse plants

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Quercus pyrenaica Willd. is an abundant deciduous oak species of the western Mediterranean basin. Its natural regeneration is seriously constrained by several factors, mostly low and scattered acorn production and extremely high rates of acorn predation by vertebrates, which makes regeneration of these forests particularly dependent on human intervention. Here, we test the hypothesis that the use of shrubs as nurse plants is an efficient technique of reforestation of *Quercus pyrenaica* forests. The survival and growth of seedlings planted under the canopy of a pioneer shrub, *Salvia lavandulifolia*, was compared with values for seedlings planted in areas of bare soil. The rationale for the study was that in environments with a dry season, pre-existing vegetation buffers summer drought stress, ameliorates the water status of seedlings, and thus usually increases seedling recruitment. Six years after reforestation, oak survival was 6.3 times higher when planted under individuals of the pioneer shrub as compared to open areas. Oaks under shrubs also had shoots 1.8 times longer, while the number of shoots per plant did not differ among treatments. The first summer was the period with the highest mortality (49.1% of seedlings), and summer drought was the main cause of mortality. We conclude that the use of shrubs as nurse plants for *Q. pyrenaica* reforestation is a viable technique to increase establishment success, and might be similarly useful in other environments and for other oak species. In addition, this technique offers the advantage of following natural succession, thus minimizing the impact in the community.

Keywords: facilitation, Mediterranean ecosystems, nurse plants, *Quercus*, silviculture.

Autochthonous species sowings in an evergreen oak stand, *Quercus ilex* L. subsp. *ballota* (L.) Samp:

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The vegetation restauration using autochthonous seeds blends was studied in a burnt oak stand. Moreover, autochthonous seeds were sown in a nursery to study the germination percentage and the seedlings establishment. The aims of this study is to investigate the seeds response in field conditions. The study area is an homogeneous evergreen oak stand belonging to the *Spiraeo obovatae- Quercetum rotundifoliae* association Rivas Goday ex Loidi & F. Prieto 1986, located in the Perdon Mountains' SE hillside which has an average slope. In november 2003, an area of 30 m^2 was cleared and divided in 181 20 cm x 20 cm plots, where 59 seeds species collected in different years (1999, 2000 and 2003) and in different evergreen oak stands beloging to the same association were sown. Each plot contains 20 seeds of species col-

lected from the same stand and year. Most of the plots have been replicated. The seeds germination and seedling stablisment were controlled during 8 months every 7 or 15 days depending on their evolution. Species germination rate and seedling stablisment and development data are presented and compared according to the different origins and different years of collection.

Keywords: Germination, seedling establisment, field conditions, different years, different stands.

Preliminary data in order to restore the bank of the Flumen river through the region of Los Monegros (Huesca. Spain)

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This preliminary study intends to evaluate water quality and ecological status of the Flumen when it flows through the Monegros as its natural hydrologic system has changed lately due to the arrival of excess water from irrigation. Three years ago the WWTS (Waste Water Treatment Station) in Huesca was put into effect and that must be considered as the starting point for the restoration or ecological rehabilitation of its banks. In order to fulfil this aim, ten sampling stations have been established along the river bed where data about physical and chemical characteristics, benthic macroinvertebrates (IBMWP) bank forest (QBR) and river habitats (IHF) are taken. Preliminary results up to the present date show that the ecological status of the river when crossing the Monegros area is defficient. Thus, the global study will try to state if the present river status is due to the insufficient period of time from the starting of the water treatment plant or to other indeterminate causes and propose and assess restoration actions.

Keywords: Physical-chemical caracteristics, water quality, ecological status, QBR, IHF, IBMWP.

Experimentation of combined physical and biological methods for the erosion control in Los Arnales gully (Monegros, Huesca, NE Spain)

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The efficiency of different erosion physical control methods, already used more or less successfully is tested combined with other biological methods, mainly recolonization with original species which are adapted to climatic conditions of the study area. The objective of the test experiment is to integrate a self-sustaining system into the gully dynamics. The study area is located in a tributary watershed of the Flumen River, in the local region of Poleñino (Los Monegros County, Huesca, Aragon, NE Spain). It is a torrential gully which gets the rain water coming from a large area, into a morphoclimatic system with continental influence, and semiarid according to Dantic climatic index. Within these conditions the first erosion factor is the diffuse flooding due to the poor rainfall which removes the soil in a zone characterized by a low plant cover which is strongly decreased due to hard cattle grazing pressure. Data about soil retention obtained from erosion plots established in experimental basins let comparison of different methods of erosion control. The Program Against Erosion of Monegros (PAEM), which uses these experimental tests will be presented.

Keywords: Erosion control, soil conservation, plant regrowth.

Ecological effects of Piskory Lake restoration in Poland

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The Piskory Lake (situated near the Wieprz River mouth to the Vistula River, SE Poland) constituted a shallow, medium-size lake surrounded by forested sand dunes. At the beginning of 70ties it was nominated to the range of nature reserve as a very valuable bird site. Agricultural drainage system and the groundwater cone of depression from the Pulawy city (located 8 km north from the lake) caused a gradual degradation of this object up to its total disappearance in 1990. In 1993 the project of restoration of Piskory Lake and ecological enrichment of surrounding area has been undertaken. Hydrotechnical activity relayed on the charge of the water supply and the outflow reduction led to restoration of the previous lake area (126 ha, mean depth 1,5-2,5 m). Over next 3 years biological diversity visible increased; water plant communities intensively developed, especially emergent vegetation and characeans underwater meadows and many valuable invertebrate and waterfowl species appeared. In 1996-98 was successfully realized the project of restitution and introduction of some rare plant species (particularly *Marsilia quadrifolia*, extinct species in all natural

habitats in Poland). The ecological effects of the project were so high, that in 2000 this area received the status of nature reserve. In May 2005, 10 years after successful finish of the project are planned comparative studies of water biocenosis actual state. Obtained results will be presented on the Conference.

Keywords: Lake, restoration, *Marsilia quadrifolia*, nature reserve, Piskory Lake.

Ecological vs. conventional urban planning and development of Zaragoza urban zone, NE Spain

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Urban zones develop following different models of use of the territory and natural resources. Many cities followed a model of progressive enlargement occupying areas surrounding a central core zone while natural habitats and resources were eliminated, transformed as land use and land cover were changing. Zaragoza urban zone followed this typical model from historic times, beginning in a core zone at the shores of the Ebro River, close to the mouths of its affluents Gállego and Huerva. During the XXth century the model of growth continued with major axis of preferential enlargement along the river banks. At the turn of the new century, this model of amoeboid growth continues but enlargement includes now steppe areas between river valleys which set up a critical challenge for the sustainability of the city. A landscape design approach shows that connectivity between zones of the same habitat (e.g., along a river) is continuously reduced as it is taking place among different habitats surrounding the urban zone because of industrial development, road and train constructions, and new urban developments. Approaches at landscape and habitat scales show where decreased environmental quality is observed with respect to reference sites. An alternative proposal of urban zone design is presented which integrates urban development into values and functions played by natural ecosystems and resources.

Keywords: urban zone, natural resources, spatial model, sustainable development.

Functionality and construction of cyprinid passage facilities along the Guadiana river basin, (SW Spain). An overview of construction designs and improvement of cyprinid migrations

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In order to minimise the negative effects of transversal constructions, dams and weirs, on migratory cyprinid populations. Confederación Hidrográfica del Guadiana has developed a project to design and build fish passage facilities. The right design and location, as well as maintenance, of different fish pass partially reduced the negative effects of transversal constructions. Functionality of fish passage facilities was previously studied in respect of few constructive parameter of hydraulic and biological nature. Criteria, such as flow velocity, and composition and ecology of the ichtyofauna directed the different designs of cyprinid passes. With obtained results, pool fishways, vertical slot fishways, fish locks have been the fish passage facilities build for each case.

Keywords: Cyprinid passage facilities, upstream migration, Guadiana river basin.

Germination biology of arid zone vegetation in the Shark Bay World Heritage Area

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Shark Bay Resources (SBR) operates a solar salt facility within a unique World Heritage Area at Shark Bay in Western Australia. Little is known of the natural processes driving plant recruitment, and SBR is committed to undertaking rehabilitation of 140 ha of borrow pits. To successfully broadcast seed and produce greenstock for revegetation it is essential to understand the germination ecology of Shark Bay's indigenous species. The Shark Bay area has an arid climate with winter rainfall, and occasional summer cyclonic systems. This study, observed the effect of fluctuating temperature simulating summer and winter (33/18ºC and 26/13ºC), gibberellic acid, smoke water, and the newly discovered chemical in smoke (3-methyl-2*H*-furo[2,3-c]pyran-2-one), a butenolide, on the germination of several dominant species at SBR. Initial results show that some species are able to germinate under summer or winter conditions. Other species exhibited after-ripening (seed germination required 4 months storage), physiological dormancy (seed germination required winter temperatures

following 5 weeks incubation at summer temperatures), physical dormancy (seed germination required treatment with hot water) or a requirement for butenolide (seed germination was promoted 16-fold). Implications of the findings for rehabilitation are discussed. The study is of regional significance to land managers and conservation agencies with an interest in restoration of other arid zones around the world.

Keywords: seed germination, dormancy, restoration, 3-methyl-2*H*-furo[2,3-c]pyran-2-one, arid zone, World Heritage Area.

Restoration of high mountain ecosystems after the removal of a ski resort (Peñalara, Central Spain)

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In 1969 a ski resort was constructed in the Massif of Peñalara, one of the areas with major ecological value of Central Spain. The construction and functioning of the ski resort provoked the elimination of rocky places and vegetation, the formation of esplanades and terraces, the transformation of the hydrological net, the drainage of peat bogs, the triggering of erosive process and a strong landscape impact. In 1999 it was initiated an ambitious project of restoration with the objective of complete dismantlement of the ski resort and the restoration of the ecosystems altered during its construction and functioning. The restored area occupies more than 24 hectares, including 6 ski runs, 8 ski lifts, a hundred of metal posts, and more than 20 buildings and constructions. The restoration project has 3 phases: 1) dismantlement of all the infrastructures; 2) restitution of the original relief and regeneration of the drainage net; and 3) restoration of the plant cover. The first two phases are already finished and the third one is very advanced, with very satisfactory results. In this work all the restoration task are described, with some recommendations applicable to similar projects of restoration in high mountain areas.

Keywords: Ski resort, restoration, alpine ecosystems, high mountain, landscape.

Environmental flows setting in Mandeo River (La Coruña, Spain) using the Instream Flow Incremental Methodology (IFIM)

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This work aims to develop the guidelines to determine the environmental flow regime in the river Mandeo (La Coruña, Spain), in the bypassed reach from the diversion dam to the restitution point of the Mandeo-Zarzo Powerhouse. This initiative arises due to the necessity to harmonize the hydroelectric generation with the preservation of the aquatic ecosystem, and it is the result of the application of the well-known IFIM methodology ("Instream Incremental Flow Methodology") to evaluate the effect of flow modifications on the fluvial habitat. Morphological and hydrological parameters have been analyzed jointly, as well as the biological ones included through the Habitat Suitability Criteria of the target species. Three representative reaches have been selected, containing a total of 14 cross sections, in which two water surface level and one complete velocity distribution have been collected, in order to create the decisive relationship between the discharge and an index for habitat suitability using the software RHABSIM. The analysis of the time series of habitat created with different alternatives has allowed setting the Instream Flow recommendations with scientifically basis, with defined ranges of flows specified for the different periods of the year, including controlled ordinary floods to maintain an acceptable interaction with the riverine processes.

Keywords: IFIM, PHABSIM, instream flow, habitat.

Restoration of floodplain forests, from diagnosis to action: The case of the Arve River (French Alps)

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The Arve River is a tributary of the Rhône River, flowing as a braided river system from the Mont Blanc Mountain. In the aftermath of the Second World War, substantial gravel mining was undertaken both within the main channel of this river and on the adjacent floodplain (10 millions of m^3). The intensive gravel abstraction activities resulted in important modifications of the alluvial corridor. These include: (i)

active channel degradation and narrowing due to vegetation encroachment onto the riverbed and (ii) fragmentation and structural modification of the floodplain forest (notably, the gradual replacement of softwood tree species by hardwood tree species as groundwater levels dropped and the frequency of flooding and bank erosion declined). A river restoration project, supported by the European community LIFE programme, has been initiated to manage and restore ecological, landscape and recreation elements of the remaining alluvial forest patches within the river valley (1000 ha of forest at 3 different sites). A preliminary diagnosis has been undertaken to describe these forest units, their associated habitats (inter-annual field survey of permanent plots, assessment of tree growth) and their temporal evolution (historical mapping using GIS and a sequence of aerial photos: 1945-2005). This information has been used to produce a range of restoration scenarios for this corridor in 2004 (identification of sites and actions to be taken). Restoration measures that have been proposed to local districts and river managers include the promotion of greater flooding incidence by lowering artificial banks and through the removal of groins. Also, the reconnection of former river channels to the main river and re-vegetation of areas abandoned by gravel miners... Following a presentation of the framework for diagnosis and results, we analyse the compromises that must be made between the technical feasibility of restoration proposals and chosen scenarios.

Keywords: floodplain forest, riparian restoration, pioneer units, LIFE programme, monitoring, alluvial corridor.

Mathematical modelling of ecological characteristics of Chernobyl Cooling Pond

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Chernobyl Cooling Pond (Ukraine, surface area about 23 km2) was created on the river Prypyat floodplane by construction of surrounding dyke and used as a source of cooling water for Chernobyl NPP units. The pumping of water from the river Prypyat into Cooling pond (CP) for compensation water losses for evaporation and filtration is fulfilled. NPP was shut down in 2000, thus the CP has lost it's main function as the source of cooling water for reactor cooling systems. Chernobyl Cooling Pond is contaminated with radionuclides and heavy metals and need ecological restoration. The remediation options being considered include a controlled draw down of water level and stabilisation of exposed sediments. Such changes would have a major impact on the Cooling Pond ecology and on the transfers of radionuclides. For the estimation of ecological impact of application of these restoration options the ecological modelling is used. The annual dynamics of N Ammonia, Nitrate N, Inorganic Phosphorus, Dissolved Oxygen, Phytoplankton, Organic P, Organic N was modelled and verified using measurements data for 2002-2003. The WASP model of EPA USA was used. Special emphasis was placed on the modelling of concentration of N ammonia as this parameter has been proved to influence radiocesium behaviour. The results revealed that pumping of water from river Prypyat into CP may have significant influence on it ecological characteristics. Observations revealed high biomass of winter phytoplankton in the CP, which was not taken into account for this stage of modelling. The both facts need additional investigations.

Keywords: ecological modelling, nutrients, phytoplankton, WASP, radionuclides, Chernobyl cooling pond.

Environmental improvement of an artificial oxbow

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The Grove of La Muga is an oxbow severed from river Arga after the canalization works carried out in the past. This project sought to naturalize the oxbow solving some of the identified problems (deterioration of the riverside vegetation, deposition in the oxbow, homogenization of the environment, excessive human pressure) with the purpose of improving the carrying capacity of species and habitats included in the Directives 79/409 and 92/43 and present in the site, as habitat 92A0 (Mediterranean willow and poplar groves), European mink (*Mustela lutreola*), otter (*Lutra lutra*), night heron (*Nycticorax nycticorax*) or french nase (*Chondrostoma toxostoma*). This space is included in the Nature 2000 Network in Navarra and it includes two Natural Protected Sites. In order to reactivate the water flow along the oxbow and diminish the deposition speed, the floodgates that allow the entrance of water to the system were repaired; to increase the habitats diversity, bioengineering techniques and plantations were carried out and the flooded surface was increased through the excavation of 25.000 m^3 of old fillings (covered during the canalization), creating new channels and islands; finally an area of public use was created where visitors can enjoy the natural environment, liberating from human pressure the most sensitive areas in the oxbow. The follow up plan will allow to evaluate the validity of the works in next years.

Keywords: Oxbow, environmental improvement, bioingeneering, public use.

Multi-criteria evaluation for restoration of forest ecosystem in Alcañiz, Spain

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Ecosystem management is a key strategy for sustainable development of natural resources. A workable definition of ecosystem is necessary to manage ecosystems successfully. Overall Alcaniz landscape is divided 6 ecological regions with 14 sub-ecological districts. The study area is located in the center of Alcaniz where two ecological zones in the north and south of town are described. Mollisols, Inceptisols and Entisols are the dominant soils in the study area. Almond, olive, vine, and barley are the essential agricultural products. Natural pines and restocking are the major species in the uncultivated areas where steep slopes are found. Deforestation of the natural pines ((*Pinus halepensis)* over the hilly landscape with steep slopes is accelerated soil erosion. In this research, reforestation and increasing biodiversity of the study by multi-criteria analysis, area were evaluated using GIS tools. Soil depth, slope, geomorphology, parent material, land cover and land use properties were chosen as multi-criteria approach parameters. Results showed suitable areas to *Pinus halepnsis*, *Quercus coccifera*, *Rosmarinus officialias* and *Rhamnus Lycioides* that were the most suitable species to prevent soil erosion and rebuild biodiversity in this area.

Keywords: sustainable development; soils; Alcañiz.

Mycorrhizal herbaceous plants in the land use types of an agro-forest landscape in Northeastern Thailand

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We assessed mycorrhizal colonization in plants from different agricultural fields, fallows in different stages and from a forest at Na Haeo Forest Reserve (NHFR), Tambon Na Haeo, Loei Province in Thailand. Mycorrhizal colonization by arbuscular mycorrhizal fungi was found in the roots of 48 out of 49 investigated plant species. This study points out that arbuscular mycorrhiza may play an important role in this low-input agroforestry system, in food production, in restoring fields through fallow periods and in forest succession. The mycorrrhizal nature of many weedy species points to their potential role in maintaining mycorrhizal inoculum and network in low input systems.

Keywords: Arbuscular mycorrhiza, crops, weeds, fallow, slash and burn, low-input agriculture.

Ecological restoration of cleared easements in high voltage transmission lines: a practical application in the region of El Bierzo (León, Spain)

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The crossing of a high voltage transmission line through a woodland entails, in most cases, the fragmentation of the landscape and has a permanent effect on the crossed ecosystems (affecting flora, fauna, soil…). This fragmentation derives from conventional management practices, which include periodical clear-cuts under the cables to ensure long-term upkeep of security distances. In this study different techniques are put into practice to take on the ecological restoration of a 5.5 km section of cleared easements of the Spanish transmission grid. The section, located in the region of El Bierzo (NW of Spain), was divided into four parts according to the different vegetation formations crossed and the land uses. In each of them, the restoration was undertake in an independent way seeking for the reduction of environmental impacts and economic loss of land owners, as well as long-term upkeep of security distances and reduction of costs for the transmission grid managers. Restoration techniques included: modifying the clearing area design (from fixed to variable width), selecting the species to clear-cut, modifying the manteinance techniques or the vegetation formation under the cables. The methodology developed for the analysis, diagnosis and selection of restoration techniques, allows the extrapolation of the results to the ecological restoration of other sections of cleared easements of transmission grids.

Keywords: high voltage transmission lines, cleared easements, restoration.

A survey of calcareous grassland restored from arable land in southern England

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Calcareous grassland restoration sites should be investigated to see how they resemble the target ecosystem. By carrying out a wide scale survey it should be possible to obtain better knowledge of how long the restoration process takes, whether different aspects of the ecosystem are restored at different rates, and whether management techniques make a difference. 40 sites, each having undergone between 2 and 60 years of restoration management, were selected by stratified random sampling. Each was compared with a control, an area of nearby ancient calcareous grassland. Vegetation surveys were carried out at all sites, together with estimates of decomposition rates, and information on management activities. Soil collected at each site was used in a productivity bioassay and for nutrient analyses. Standard deviational ellipses for each site were produced from the results of a multivariate CCA of plant species cover data. Regression analysis of the distance between the control and restoration ellipses showed that both restoration treatment (natural regeneration, simple seed mix, complex seed mix) and the age of restoration explained a significant amount of the variation. CCA also showed that soil characteristics (particularly soil phosphorus and soil productivity) can constrain restoration success. We conclude that restored sites in general become closer to the target ecosystem over time, but that the timescale studied here was not sufficient for the process to reach completion, and that certain seeding strategies and a high residual fertility may have a negative effect.

Keywords: Calcareous grassland, multivariate statistics, restoration, management, soil productivity.

Monitoring and restoration of coral reefs damaged by the ship grounding of the bulk carrier Amorgos in Kenting National Park, Taiwan

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The bulk carrier Amorgos grounded on coral reefs of Lungken Nature Reserve, Kenting National Park in southern Taiwan on 14 January 2001. Coral coverage of the area has been denuded as a result of the mechanical abrasion of broken wrecks during typhoon period. The recovery process of coral community at the damaged spur-and-groove site was monitored by 3 permanent 1×1 m quadrates on denuded natural substrata at a depth of 6 to 12 m. The total number of recruited corals was 5, 93 and 62 and the mean coral coverage was 0.23, 0.95 and 1.20% in October 2002, August 2003 and September 2004, respectively. In addition, the mean coral coverage estimated using belt transect survey (1 to 3 30×0.2 m) was 63.6, 44.4 and 28.0% in October 2002, August 2003 and March 2004, respectively. This suggests that natural recovery was very slow and coral growth was still inhibited. The family *Faviidae* was the most abundant recruited colonies (55.8%), followed by the family Poritidae, Alcyoniidae and the blue octocoral Heliopora coerulea. The family *Faviidae* and *H. coerulea* were common at nearby site. The recruitment pattern of Lungken was different from other sites in Taiwan where recruitment usually was dominated by pocilliporids and acroporids. It suggests that recruitment at Lungken might be influenced by nearby coral communities. A restoration study will be conducted to assess the feasibility of transplanting cultured corals and settling larvae to enhance recovery.

Keywords: Coral reefs, monitoring, recruitment, restoration, ship grounding.

The use of the rivers between urban and rural areas- the example of the Ipojuca River in the state of Pernambuco northeast of Brazil

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The use of rivers, and their waters and banks is problematic for the environment in the whole world. The scarcity of this resource and its heavy pollution and economic activities already cause problems in countries like Brazil. This study aims to analyze the Basin of the River Ipojuca that represents the main link between the Sertão, a semi-arid region in the interior where important and traditional cities can be found, and the coast in the State of Pernambuco, northeast of Brazil. The purpose is to identify elements that compose the river zone, to monitor the quality of the water in the Basin of the Ipojuca by combining

the main natural and socio-economic factors of the last years. The river Ipojuca has a length of 250 Km and gives material to support the existence of 600.000 inhabitants directly and indirectly more than 1.500.000 inhabitants, being today the corridor of the Ipojuca, an area of a great economic dynamics. Through the evaluation of landuse, hydrologic resources and data on sources of pollution and use of the water, it was possible to elaborate maps of use and landuse and monitor of the quality of the water. The result characterizes the types of use and occupation of the land in the region: environmental relevant, agribusiness, fat stock, dairy cattle, urban and industrial. Thus, it was possible to know exactly where each economic activity takes place and to establish plans for the control of sources of pollution and for the restoration of the river.

Keywords: River, landuse, restoration, hydrologic resources, urban and rural.

Phytoindication of the surface waters of the Canyon of the River Smotrych (NNP "Podilsky Tovtry")

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The research was held on the territory of National Nature Park (NNP) "Podilsky Tovtry", the biggest in Ukraine and the second big as for the territory in Europe. The aim of an work was to define nature and anthropogenic changes of ecosystem of the river Smotrych in the measures of its canyon, using phytoindication characteristics of macrophytes. During conducting phytoindication researches a landscape-geobotany analysis of ecosystem of the river with different level of economic development was made. To check phytoindication laws the data of chemical composition of water were used. Ecological valuation was held according to same sensitive species of macrophytes and their associations and with the usage of methodics of Dubyna, Heine and Katanska. In course of the research the spreading and ecological peculiarities of the growth of macrophytes-indicators according to hydrological and hydrochemical conditions were established. The index of phytoidication (I_f) was indicated, which characterizes the condition of waters of the canyon of the river Smotrych as unsatisfactory. The valuations of condition of water ecosystem under influence of anthropogenic press was given in the comparison of data of phytoindication researches with hydrophysical and hydrochemical parameters. On the whole phytoindication researches are rather actual especially on the nature protected territories. They give the opportunity to define integral level of pollution as well as general state of water ecosystems. At the same time we have an opportunity to make the discreet control with the help of hydrochemical methods and only in the definite periods of time. And some changes between observations. This approach to the decision of this problem gives us an opportunity to rationalize the research process and later it can serve as a basis prolonged monitoring on the larger territories.

Keywords: macrophytes, index of phytoidication, anthropogenic changes.

Eco-sourcing plants for restoration: does it matter?: A test of the inter- and infra-population variation in the New Zealand species Metrosideros umbellata

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The importance of plant provenance for restoration efforts is currently at the forefront of conservation policy. Conservation authorities advocate the use of "eco-sourced" or nearest-provenance-sourced plant material to avoid the risk of genetic pollution. However, little is known of the degree of risk, and there is a complementary concern that isolated plant communities are at risk of inbreeding depression. The need for eco-sourcing depends on the degree of genetic variation in the geographic range of a species. Here we investigate the geographic variation in morphology, isozymes and DNA in populations of Southern Rata (*Metrosideros umbellata*). Populations were sampled randomly to identify five trees within each; providing some understanding of the geographic variation within and between the selected populations. Populations were sampled throughout the South, Stewart, and Auckland Islands of New Zealand. Morphological variation was analysed by various leaf measurements, isozyme variation through a number of enzymes, and molecular variation using inter-simple sequence repeats (ISSR). In addition to the sampled populations, specimens from restoration sites (provenance unknown), commercial cultivars and local garden specimens were analysed to ascertain their potential genetic threat. There was little variation in morphology, but the molecular results revealed considerable variation within and especially between populations. We conclude that genetic depression is unlikely, but that the use of eco-sourcing is important for this species.

Keywords: Restoration, population variation, provenance, DNA, ISSR.

Potential use of multiple values of vegetation optical depth on land surface parameter retrieval from microwave emission on heterogeneous regions

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Microwave emission from the land surface can be used to predict land surface parameters for monitoring ecological restoration at large scale. Among these are soil water content, soil temperature and vegetation optical depth.Using multiple microwave vegetation optical depth values (an indicator of vegetation density) when retrieving land surface properties from microwave emission increases accuracy when retrieving other parameters. Vegetation density, particularly at the spatial scale of a satellite instrument, shows significant variation but is normally assumed for retrieval purposes to have a constant value within the radiometer footprint. To simulate areas with a range of vegetation optical depths, using the Tau-Omega model, brightness temperature curves as a function of look angle (six angles from 0 to 50 degrees off-nadir) were generated for ideal vegetated scenarios based on soil water content values of 0.1 and 0.4 m^3m^{-3}, and vegetation optical depths ranging from 0.0 to 0.6 in randomly-selected proportions. Algorithms then attempted to retrieve the soil moisture, vegetation optical depth and surface temperature from the simulated observations, assuming a single vegetation optical depth. Soil moisture retrieval error for a six-angle sensor induced by vegetation optical depth variability when a single optical depth is assumed are larger for wet soils, and are on average 0.026 m^3m^{-3}, rising in the worst cases to 0.047 m^3m^{-3}. This effect can be substantially reduced by modifying the Tau-Omega model to retrieve variables assuming that the vegetation is a mixture of two optical depths, when the RMS error drops to 0.007 m^3m^{-3}.

Keywords: microwave emission, vegetation density, land surface parameter.

Landscape rehabilitation based on water inundation and landuse change - new challenges for the Tisza region in Hungary

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To protect the high biodiversity of the Tisza valley (Hungary), where Ramsar sites have been introduced already is important. The Great Hungarian Plain is a typical evaporative basin with unsustainable landuse and water management, and bad drainage conditions. A few hundred years ago natural forests, grasslands and wetlands were typical for this region, which has been destroyed due to massive canalisation, deforestation, drainage and agricultural utilisation. Climate and land use changes caused increasing frequency of the extreme flood and drought events and loss of biodiversity. Initiatives at local and national levels were started to analyse the multifunctional rehabilitation possibilities at landscape level and to define proper measures. Water management is based on periodical floodwater reservoirs and furthering down water steering (sallow water inundation) based landscape management to store the water of flood periods and lead back to the Tisza River with 30-40 days delay. A monitoring system was set up in the Bodrogköz pilot area to follow changes in soil formation, surface and groundwater regimes, land use and vegetation at 4 different elevation categories. A spatial soil database is being constructed, based on profile and soil pattern information. Changes in soil water regime will be linked to changes in natural vegetation, habitats and agricultural landuse. Comparison of the effect of present and proposed optimal landuse systems on soil water regime is to be performed. First results of the scenario analyses (modelling) to support the regulation of water flow in accordance with the ecological water demand are going to be presented.

Keywords: anthropogenic effects, water management, land use changes, integrated monitoring system, soil moisture modelling.

Influence of soil changes on natural regeneration in abandoned oil and gas fields of Northern Patagonia (Argentina)

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Oil and gas exploitation constitutes a widespread and highly severe disturbance in arid shrub steppes of Patagonia. Natural regeneration of abandoned locations takes at least 45-60 years to reach 75% similarity in vegetation and burrowing wildlife composition and diversity with control areas. In order to reveal

how changes in soil properties influence ecosystem rehabilitation, we investigated temporal trends in pH, electrical conductivity, gravel content and organic matter content in soil cores of 13 abandoned locations representing a 35 years chronosequence. We used a paired sample design, in which each oil/gas abandoned location was compared to a nearby reference site (control). Differences in the values of each of the four variables between the abandoned location and the control site were calculated for two habitat types: open (bare soil) and vegetation (mounds) patches. Temporal changes in these differences were examined by linear regression analysis with post-disturbance time as the independent variable. Our results indicate that only gravel content varied significantly with post-disturbance time in both habitat types: r= -0.70 ($p< 0.001$) and r= -0.58 ($p< 0.001$) for open and vegetation patches, respectively. These results suggest that, in general, plant establishment is not primarily related to changes in soil properties; however, the considerable decrease in gravel content might play a role in the development of microsites suitable for germination, at least of some species.

Keywords: Temporal soil changes, oil fields, Patagonia, soil physical properties, restoration.

Response of *Pinus halepensis* Mill. seedlings to sewage sludge and trace elements in three Mediterranean forest soils

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The success of restoration actions in the Mediterranean Basin may be hampered by soil impoverishment. Sewage sludge currently represents an easily accessible source of organic matter and nutrients that could be used to restore degraded ecosystems. However, sewage sludge containing trace elements could compromise seedling performance. The aim of this work is to evaluate the phytotoxic effect of sewage sludge enriched in Cu, Ni and Zn on *Pinus halepensis* seedlings under semiarid Mediterranean conditions. We selected three soil types frequently found in the forest areas of the Mediterranean basin. We filled 40 x 40 x 70 cm lysimeters with unamended soil, a mixture of soil and dried sewage sludge, or a mixture of soil with sludge enriched in Cu, Ni and Zn. Sewage sludge application rate was equivalent to 60 mg ha-1. Gas exchange rates and chlorophyll fluorescence were measured once in spring and twice in summer, before and after an artificial watering. After 8 months, biomass accumulation and concentration of trace elements in current's year shoots and roots were evaluated. Biosolid application resulted in a weak reduction in Cu and Zn concentration in needles, negatively affecting physiological status during drought. This effect was alleviated by the application of enriched sludge, as this treatment resulted in a significant increase in trace element concentration in roots and needles. Concentrations were still below phytotoxic levels. Sewage sludge with relatively high levels of Cu, Zn and Ni had minor effects on plant performance under semiarid Mediterranean conditions and carbonated soils. On the contrary, results suggest that nutritional limitations may be alleviated by the application of sewage sludge enriched in trace elements.

Keywords: Pinus halepensis, trace elements, sewage sludge, reforestation.

FishXing 3.0. Software modeling environment and learning systems for assessing fish passage through culverts

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The Forest Service has produced a software model –called FishXing– that facilitates assessing and designing stream crossings. Pronounced "Fish Crossing", this software is designed to assist engineers, hydrologists and fish biologists in the evaluation and design of culverts for fish passage. It is free and available for download at the FishXing website. FishXing models the complexities of culvert hydraulics and fish performance for a variety of species and crossing configurations. The model has proven useful in identifying culverts that impede fish passage, leading to the removal of numerous barriers. As a design tool, FishXing accommodates the iterative process of designing a new culvert to provide passage for fish and other aquatic species. Version 3 is a complete rewrite of previous versions based on user feedback and our own experience in the field of fish passage and engineering, and is expected to be available in the Fall of 2005.

Keywords: Fish Crossing, stream, culvert.

Analysis of vegetation and fish response to restoration of a tidal marsh in Guadalquivir River Estuary

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Dredging filling late in the 1980's destroyed the Algaida Marshes of Guadalquivir River Estuary. The restoration of Algaida Marshes was carried out during 2000 Summer by removal of dredged material, geomorphologic reconstruction of surfaces and substrates and restoration of tidal flow. The colonization of the area was achieved by natural mechanisms (water flow). In this study the development of vegetation and the use of restored marsh channels by fish over the last five years is presented 18 permanent plots (5 x 5 m) were marked along 9 transects, covering main topographic gradients. The composition and biomass of vegetation within each plot was recorded in July 2001 and 2005. Fish sampling was carried out in 2002-3 (monthly) and 2004-5 (seasonally). Using fish traps, fourteen sites including channels, mudflats and vegetated areas were sampled. Results show a rapid development of vegetation succession. Within 3 years large areas of mudflats were covered with marsh vegetation dominated by *Spartina densiflora,* turning denser with time. Restored marshes were immediately colonized by fish. 9620 fishes belonging to 22 species were collected. One introduced species, killfish (*Fundulus heteroclitus*) composed 76% of all collections. Native *Liza saliens* (11,5%) and *Pomatoschistus microps* (7,7%) followed in abundance, all other species contributing less than 2%.

Keywords: marsh vegetation, restoration, tidal influence, fish, monitoring.

General strategy in the environmental impact assessment of the As Pontes lignite open pit lake (Galicia)

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When the As Pontes lignite mining is finished, in 2006, the open pit will became a lake, observing the "Restoration Plan of Puentes Mine", formulated in November 1983. Lake area will be 8 km^2, divided in two parts, West Field and East Field with maximum depths of 200 and 60 m, respectively. The general strategy underlying the open pit restoration project has been considered at real scale. Its principal objective consists on changing a 540 Hm^3 mass of water in an ecosystem in the best chemical and biological conditions as possible, so it could be sustainable. Improvement of the lake productivity, as an integral part of this strategy, seems the very first, short term objective to promote the lake sustainable functioning: It'll improve the final water quality, increasing the diversity of uses of the future lake, as compared with an acid mine lake. All the project development alternatives indicate that hipolimnium will be always anoxic. So, impelling some processes of great environmental interest mediated by microorganisms (for example, sulphate reduction), will transform the open pit in a biological reactor, where we can favour the culture of those microbial species that can help us to solve the problems or limitations inherent to the physical environment.

Keywords: Acidic mine lake, environmental impact assessment, sustainability, sulphate reducing bacteria.

Establishment of shrub species in a semiarid ecosystem after inoculation with native arbuscular mycorrhizal fungi in the Mesquital Valley, Hidalgo, Mexico

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Shrubland ecosystems are dominants in the Mesquital Valley, at the Hidalgo State, Mexico; there, biological resources abundance are usually triggered by rainfall events and typically go trough wet and dry periods. In this environment, the arbuscular mycorrhizal (AM) fungi supports establishment, favors growth and increases the drought tolerance of plants. In this work, the AM fungal association was analyzed in twenty native plants species, moreover several AM native inoculums were produced. For this, the source of AM spores was taken in a native soil of the Mesquital Valley. The native AM fungi spores were successfully multiplied in pot cultures. *Lolium multiflorum* was used as host plant. Once germinated, emerging seedlings of *Prosopis laevigata*, *Acacia farnesiana*, *Mimosa biuncifera* and *Opuntia strepthacanta* were transplanted into growing substrate consisting of sterilized soil with AM fungal inoculum (5% v/v). Inoculated and non-inoculated seedlings were grown for 6 months under greenhouse conditions; plants were

watered when necessary and fertilized with Long-Ashtong solution. The next plant variables were evaluated: AM root colonization, shoot weight and root/shoot ratio. After this, inoculated and non-inoculated plants were planted in natural field conditions of the Mesquital Valley. One year after planting, survival and growth were evaluated Inoculated plants were significantly greater than non-mycorrhizal plants; also, AM treatment increases shoot biomass and survival percent. Therefore, the use of native AM spores as a source of biofertilizer inoculum may be considered as a emergent strategy for the successful re-establishment of natural plant populations, in order to restore mesquital communities in shrubland ecosystems.

Keywords: Arbuscular mycorrhizal fungi, establishment, semiarid ecosystem, shrub species.

A scaling of contaminated ecosystem: Ecological risk and optimization of environmental management

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It is developed the criterion "Ecological Risk" *R* for contaminated ecosystem in terms of ecosystem indices, which are reflected contamination of several ecological chains by several pollutions including radionuclides. It is developed the one-dimensional ecological scale where experts in terms of the relative ecological conditions assign the scaling factors. The *R* of the contaminated ecosystem is reflected by ecological scale location; change of the *R* is reflected by evolution of the ecosystem location along the scale. This tool is based on the following procedures: reduction of the monitoring data dimensionality, discrimination, clusterization, classification, multiple regression analysis and expert analysis for assigning of the relative ecological conditions. This method is intended for analysis of environmental information having chaotic and intricate structure. The evolution of *R* along the ecological scale may be used for Cost-Benefit Analysis of environmental management including tasks of restoration. Here criterion of ecological condition *R* is linear combination of several ecological characteristics. The coefficients of weighting for *R* are determinated by internal structure of ecosystem contamination. This tool is demonstrated using two contrast examples (Rovenskaia Area of Ukraine): i) contamination of several ecological chains by single pollutant and ii) contamination of single chain by several pollutants.

Keywords: contaminated ecosystems, scaling factors, ecological chains, Ukraine.

Habitat creation on agricultural land using topsoil inversion

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This study assesses the effectiveness of topsoil inversion in promoting recovery from surface eutrophication in UK agricultural soils, a major barrier in creating new habitats of greater biodiversity. Topsoil inversion is undertaken by a deep plough, which buries 30 cm of topsoil under approximately 40 cm of subsoil. The study site includes: 1) a newly inverted area, with conventionally ploughed control to compare two habitat end-points across the two ploughing types: wildflower meadow, and wildflowers with trees, and 2) 2-year-old inverted and conventionally ploughed areas planted with trees and either wildflowers or grass. Measurements were of soil properties and soil seed bank down to 1 m depth, and of tree growth. Topsoil inversion significantly changed the profile of soil nutrients, water and organic matter content. The seed bank, found in surface layers of control soils, was buried to a depth of 30 – 60 cm by inversion. Tree growth was dramatically increased in inverted soil. Topsoil inversion therefore results in a decrease in surface fertility, and the burial of competitive weed seeds. These factors may favour the establishment of wildflower meadows due to the reduction of competition with undesired species, and a change to lower fertility surface conditions favoured by many wildflowers. Topsoil inversion also greatly benefits the establishment of planted trees. However, this benefit is partly negated by undersowing with grasses, currently the favoured forestry practice in the UK. These findings suggest that topsoil inversion has the potential to facilitate habitat creation on eutrophic substrates.

Keywords: Eutrophication, habitat creation, seed bank, soil nutrients, topsoil inversion.

Facilitation of tree saplings by nurse shrubs: microhabitat amelioration or protection from herbivores?

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In Mediterranean environments, spatial patterns of regeneration of many tree species are associated to shrubs. Protection against summer drought and herbivory, two main disturbance agents in Mediterranean systems, have been proposed to underlie such patterns. However, their relative importance is poorly understood. In this study, we experimentally analyze during 5 years the effects of shrubs, ungulates (mainly *Capra pyrenaica*), and their interaction in survival and growth of saplings of four Mediterranean tree species: maple *Acer opalus* subsp. *granatense*, holm oak *Quercus ilex*, black pine *Pinus nigra* subsp. *salzmanii*, and Scots pine *Pinus sylvestris* var. *nevadensis*. Shrubs had a similar positive effect on sapling survival both inside and outside experimental exclosures. Thereby, facilitation was independent of the presence of ungulates, microhabitat amelioration appearing as the main facilitation mechanism of survival during the 5 years of study. Moreover, facilitation intensity varied between species, being only significant for maple and holm oak. Herbivory damages also varied widely between species, being much higher for maple than for any other species. Shrubs did not protect maple saplings against ungulates, all maple saplings suffering herbivory outside the exclosures. Consequently, accumulated height growth of maples after 5 years was more than twice higher when ungulates were excluded. Our results show microclimatic amelioration to be a more important facilitation mechanism than herbivory protection in our study sites. However, we stress that the final balance between the two mechanisms is highly dependent on the site characteristics.

Early revegetation after hydroseeding on coal-mining spoils

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The aim of this study is to monitor bimonthly the changes in plant cover on mining slag-heaps (North Spain) along the first year after hydroseeding. Three sampling sites were selected, two at 20º incline (north, south) and one flat. Cover of all species presents within three 16 m^2 plots were sampled in each site. Total plant cover increased with time reaching the highest values in Spring (80% on the north slope; 70% on the south one and, 60% on the flat site), when the contribution of native species was around 10%. During the first nine months of revegetation, the cover of grasses was higher on the north slope, whereas the cover of legumes was higher on the south one. The multivariate analysis showed that only 11 species were responsible of differences in floristic composition between sites, among which three non-introduced species were included. In the flat site no differences between these species groups were found. It can be concluded that, in the study area, the contribution of native species to total plant cover is not valueless for the period analyzed, and that there was a different development of grasses and legumes according to the aspect.

Keywords: Aspect, native and introduced species, plant cover, slope inclination.

Ecological and landscape restoration of the ancient fountains in "Tierra de Campos" Region (Valladolid-Palencia, Spain)

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"Tierra de Campos" is a semi-arid plain inside Duero's river basin. The historical and intense agricultural use has caused disappearance of natural forest and degradation of rivers, riparian and humid zones. In this landscape they highlight a singular joint of old fountains that nourished with their excellent waters, even considered as medicinal, to the villagers. In addition these locations constitute a wildlife shelter and a greenness oasis in this steppe zone. This project deals with 31 fountains restoration distributed in four townships. It aims a natural heritage recovering of great scenic and ecological value of the landscape, also causing positive socio-economic impacts to villages. In order to obtain an integrated landscape restoration, following sections have been contemplated: traditional architectonic fountains reconstruction, creation of new pathes and improvement of the old ones, native reforestation, ecological restoration of the stream banks and recovery of associated wetlands, garbage cleaning, installation of furniture and information panels. Project general budget raises to 501.903 € (≈ 16,000 €/fountain), allowing a planned and periodic execution during the next years by the Autonomous Government (Junta de Castilla y León). In addition to the ecological and landscape

restoration and historical heritage, this project will attract rural tourism and will help to avoid the continuous depopulation of the area in a compatible way with the current agricultural activity of their lands.

Keywords: Springs, water conservation, reforestation, Duero's river basin, steppe zones.

Matching conservation and valorisation goals to delimit local provenance for native plant species used in ecological restoration

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Turning revegetation process into a real ecological restoration implies native plant species to be used. However, the use of native plant species in large scale revegetation program requires a sustainable source of seeds of native plant species that meet the technical request of the revegetation process. Since seed collection from the wild is likely insufficient to support the demand, native species must undergo a *ex situ* seed multiplication. The purpose of the present work is to develop a method to delimit local provenance and seed collection zones matching conservation and agronomic goals. This method relies on an analysis of the relationships between phylogenetic structure and local adaptation, their impact on phenotypic traits related to fitness, seed production and colonisation ability. The hypothesis is that if the environmental constraints are strong enough to shape the genetic structure of the plant species and to induce an ecological convergence between species, there are simple environmental indicators to be used to design seed zones. The final delimitation of such zones would be the result of a collective work between all the actors of the ecological restoration process. This work takes place in the Ecovars 2 project for ecological restoration of damaged mountain sites in French Pyrenees.

Keywords: revegetation; native plant species; Pyrenees; local adaptation; phylogenetic structure; seed zones.

Non-native fish eradication from a high mountain lake (Laguna Grande de Peñalara, Central Spain): quick recovery of aquatic populations

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Around the 1970s, *Salvelinus fontinalis* (Salmonid) was introduced in Laguna de Peñalara, a small high mountain lake in Central Spain. Before this introduction no other fish species were found in the lake. The presence of *S. fontinalis* changed the aquatic populations: It eliminated from the lake certain species of amphibians and big-size invertebrates. On the other side, some small-size species of macroinvertebrates were more abundant after the fish introduction. In 1999 we start the eradication by means of gill-net fishing. During the eradication more than 550 individuals, up to 4 years old, were eliminated. Since then, we have observed a quick recovery of the aquatic macroinvertebrate community. The number of taxonomic families of aquatic macroinvertebrates has risen from 9-13 families previously to the impact to 23 families after the eradication. Practically all the species that inhabited the lake still persist in it, but an important number of other species have colonized the lake since the eradication. Among them we have found big-size aquatic insects (heteroptera, coleoptera, odonata) and 3 species of amphibians.

Keywords: Fish eradication, restoration, aquatic macroinvertebrates, amphibians, high mountain lake.

Riparian restoration in Ebro river floodplains (Galachos Nature Reserve, Spain)

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From 1996 to present Aragon Government is making ecological restoration activities in the riparian habitats of the Ebro River floodplains (Los Galachos Nature Reserve Zaragoza, Spain). The main goal is the restoration of the riparian habitats, also aiming to improve bird population in this protected natural area. The restoration project have achieved here an important change on the land uses. Some cultivated areas and black poplar plantations were changed into 42 ha of new riparian natural habitats, and a 2.3 ha artificial lagoon was created. After a previous study on the next natural riparian forest, plantations were performed simulating structured distribution of trees and shrubs present in old river forests by the surroundings. Some works removing grounds were made in order to ease rooting and colonization of plants with major water necessities. Restoration has accelerated the process of vegetal colonization. After

3 year since plantation a spontaneous regeneration of some species has been observed, though different results depending on fields. 5 bird species are present by the lagoon all year long up to 20 additional species use it as both shelter and feeding place and some of them even as breeding place. After restoration, it's notable in the Reserve, a general increasing trend on number of aquatic bird species seen, and on number of birds as well. This has widened offer in bird observation points inside the protected area which has also permitted to relief visitor's pressure on other bird breeding places.

Keywords: Restoration, riparian forest, aquatic birds, protected area.

Landscape change in a agrosylvopastoral area of Spain, 1956–1998. Evolution of *Dehesa*, shrublands and forests area in the Natural Park of Cardeña and Montoro, Córdoba

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Changes in human activities have produced changes in spatial lanscape heterogeneity through the creation of new uses and boundaries. In many areas of Europe, the intensification of agriculture during the past decades has led to the replacement of traditional agro-silvo-pastoral practices by more intensive exploitation, involving structural simplification and changes in spatial diversity in the landscape. However, in mountainous and marginal areas, the changes in the past two decades followed the opposite direction due to the rural depopulation and extensification and abandonment of traditional activities. We have studied changes at landscape level in the Natural Park of Cardeña and Montoro, with a total protected area of 38.449 ha, on a mostly granite plain landform, located in the south of Spain in the Sierra Morena. In order to assess landscape level change, we have used aerial photographs at two different dates: 1956 and 1999. The main land use types in each year were identified from the photographs; in order to summarize the changes, the land uses were rearranged in large groups. The area of each individual patch and other landscape metrics were measured by digital scanning. The main land use in 1956, was the sparse – tree covered pasture lands, which can be iddentified with the most productive *dehesas*. This land use type is reduced in 1998 by 10%, from 42% to 32% of the area, transformed mostly in shrubby and dense forest areas. The changes have been relevant mainly in the *dehesas* with a less density of trees. A significant percentage or shrublands in 1956 have evolved to more dense forest patches, including a 5% of new conifer woodlands in the area.

Keywords: landscape, Cardeña (Spain), land uses, agrosilvopastoral practices.

The way back from 80 years of military use to restored mountain wilderness – Hjerkinn firing range, Dovre, Norway

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The Norwegian Parliament has decided to close down a large military firing range (165 km^2) situated in the wilderness area Dovrefjell Mountain in Central Norway. Very ambiguous instructions concerning future management is given, including an enlargement of the neighbouring National Park and restoration of the firing range area. This work is put in specific terms through a joint comprehensive Development Plan that combines the interests of The Norwegian Defence Estate Agency, the two involved local counties, and environmental authorities. Several more or less consistent goals for restoration are indicated in this plan. The main focus is to restore the area in a way that entails considerable profit for the nature. A long time-scale for restoration is stressed and the main goal is to bring at least a part of the area back to an "original" state, but the need for some immediate results is also stated. Introduced species will be totally prohibited in the restoration. One important challenge is to put in use experiences from scientific restoration experiments during the last decade. The project deserves special attention for three reasons: its size (both geographically and economically), the level of ambition (bringing the area "back to wilderness"), and the type of nature involved (an intact mountain ecosystem hosting wild reindeer and wolverine). The integration of biological knowledge, technological experience and people's expectations and preferences is a challenge to the implementation of this unique nature restoration project.

Keywords: alpine, military training area, National Park, restoration, wilderness.

The beaver's reconquest of Europe–current status, patterns of spread, and implications for management

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Formerly widespread throughout much of the Palaearctic region, Eurasian beaver *Castor fiber* populations were reduced through overhunting to c. 1200 animals, in eight isolated populations, by around the end of the 19th Century. Effective protection of these remnants, the resultant natural spread, and widespread reintroductions have led to a powerful recovery in both range and population. The minimum population estimate in 2005 is 640 000 individuals. Populations are now established in all natural range countries in Europe except for Britain, Portugal, Italy, Greece, Albania and Macedonia. Habitat occupied ranges from wilderness areas to intensively managed landscapes with dense human populations, and from warm temperate to subarctic climates. Reintroductions are continuing. Considerable further expansion of both range and population, especially in western Europe and the lower Danube basin, can be expected. If current trends continue, *C. fiber* will within a few decades be a fairly common mammal throughout much of Europe. This has important implications for ecological restoration of wetlands and riparian habitats, and their subsequent management. Beavers both create, and strongly modify, wetland and riparian habitat in the course of their activities in ways which can be difficult to predict or control in detail.

Keywords: beavers, population, management, wetlands.

Some aspects of restoration and management of mountainous reservoirs

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Major aspects of using ecological monitoring of reservoirs are based on the research of hydrobionts. The general biological state of the river is based on the research of biocenosis and the appearance of indicated species. An autotrophic section, especially phytoplankton, is known to serve as an index of water quality. Separate kinds are known as species-indicators of euthrophication of reservoirs. The state of hydroecosystem is impartially characterized by the totality of hydrobiological and hydrochemical data. Settler method of exploring phytoplankton and hydrochemical analysis of freshwater reservoris by the methods accepted in modern hydroecology were used. The results obtained above illustrate succession of phytoplankton and specific structure of algae in different parts of the river, give allowance to pick out species, characteristic for pure and polluted waters, carry out comparative analysis with hydrochemical indices. The dependences of the development and successions on the degree of pollution and quantity of biogens in water are shown. A comparative analysis of floristic structure is carried out, species and indicators of water quality in surface water are revealed. On the basis of the data obtained above some recommendations on restoration and effective usage of water resources can be given.

Keywords: hydroecosystem, monitoring, phytoplankton, water resources.

Restoring native vegetation on ungulate winter range in and near Yellowstone National Park

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The area immediately north of the Yellowstone National Park, known as the Gardiner Basin, was deemed essential for elk and pronghorn winter range and acquired by the Park in the 1920s. The United States Forest Service (Gallatin National Forest) acquired adjacent lands in the Gardiner Basin during the 1990s. Due to previous agricultural land use, semi-arid conditions, altered hydrologic regimes and soil conditions, and increased exotic weeds, these acquired lands support relatively low amounts and quality of forage for wildlife. Recent unsuccessful attempts at restoration demonstrated that additional expertise representing diverse disciplines was needed to effectively restore 2,500 acres of atypical ecosystem to native vegetation and provide higher quality habitat for wintering ungulates. We convened a workshop in April 2005 with 12 state, federal, academic, and practicing restoration and reclamation specialists to develop feasible, ecologically-based restoration and management strategies for these old agricultural lands. The goals of the workshop were to: 1) formulate a directional, coordinated plan for the restoration and long- term management of the federally-owned portions of the Gardiner Basin; and 2) develop an action

plan to implement ecologically-based and sustainable practices for restoration of disturbed lands in a multi-use, semi-desert ecosystem with high levels of use by native ungulates. With the assistance of restoration experts, we developed methods for restoring landscape-scale, degraded lands to native vegetation by addressing ecosystem processes.

Keywords: native vegetation, Yellowstone National Park, ecosystem processes, wildlife.

Phytostabilisation of heavy metals for the ecological restoration of old mining regions

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Several regions of central Spain polluted with heavy metals have been given over to pasture, meadow and shrub ecosystems, established on the soils of old urban-waste landfills and abandoned mines. The present study is a continuation of previous work aimed at designing phytoremediation measures. Over the past few years, we have been evaluating autochthonous plant species that are able to extract heavy metals from soil by accumulating these pollutants. Results so far have generated an increasing interest in phytostabilizing plants, that is, plants growing in soils polluted with mine tailings whose root and rhizome systems are capable of accumulating and stabilising metals. Herein, we describe the protocol we are currently evaluating, and the results of our initial field- and experimental work. The latter includes glasshouse microcosm experiments performed on grass communities from different pasture and meadow Mediterranean continental or mountainous settings growing in soils polluted mainly with Cu, Zn, Pb, Cd and Al. Our findings indicate that the root and rhizome systems of perennials in these communities, particularly those of the genera *Agrostis* and *Juncus* and species such as *Arrhenatherum elatius* subsp. *bulbosum, Corrigiola telephiifolia, Sanguisorba minor, Plantago lanceolata* and *Scirpoides holoschoenus,* seem to be suitable both for phytostabilising some of these metals and for fixing the soils of slopes and landfills.

Keywords: pastures, shrub lands, polluted soils, Cu, Zn, Cd.

The effect of bracken on chemical and biological soil properties in a neotropical montane habitat

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Bracken (*Pteridium aquilinum* L. Kuhn) is considered a serious weed in agriculture, forestry and land restoration. Its competitive success has been attributed to genetic variability, allelopathy and soil chemical transformation. The effect of bracken on soil biological processes related to microbial activity and nutrient cycling has not yet been established. In Central and northern South America bracken grows mainly in mountain areas affected by excessive grazing and fires. We assessed the influence of bracken on soil chemical and microbial properties in recently burnt communities. Soil samples were obtained from three sites with increasing age from last fire event (<1y, 2y, 5y) and from a protected shrubland in northern Venezuela. Results indicate that fire impact on total soil carbon and nitrogen is short-lived, vanishing after one growing season. In general, microorganisms showed lower levels of biomass and activity (hydrolysis of dehydrogenase and fluorecein diacetate) compared to the shrubland. Remarkably, the activity of glucosidase, an exoenzyme involved in the transformation of cellulose, was very low, and not related to soil carbon contents. This suggests that bracken, either its leaf litter or root exudates, affects the cyclage of soil organic matter, and this might hinder the establishment of other species thus delaying ecosystem succession.

Keywords: secondary succession, *Pteridium*, soil enzymes, fire.

Major Causes driving early succession in roadside slopes

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Several recently created roadside slopes were studied in temperate and submediterranean areas of Navarra (Spain) to evaluate the causes of vegetation change. Both types of slope, cutbanks and fillslopes, were studied. Hydroseeding was applied as a reclamation measure in all the slopes. Floristic composition were monitored monthly during three years after slope creation. Biomass of herbaceous species were also measured three times a year along the same period. Both variables as well as seed production in the vegetation

over the slope were also observed along a transect from the upper to the lower part of the slopes. The number of spontaneous species and its biomass were much higher in fillslopes (with a seed bank) than cutbanks (without a seed bank). Its abundance were also significantly higher in the upper part of slopes with vegetation above it. Colonisation were also more constrained in eroded slopes under submediterranean climate. Floristic composition and the structure of vegetation varied strongly along the studied period under temperate climate, observing a decrease in biomass of herbaceous species. It can be concluded that seed availability, provided both by the soil seed bank or the seed rain, plays a major role in spontaneous plant colonisation, being the soil seed bank a more effective mechanism than seed rain. On the other hand, microsite availability constraints plant colonisation as abiotic conditions become more severe whereas competition cause rapid changes in floristic composition mainly below mild abiotic conditions.

Keywords: colonisation, hydroseeding, seed availability, microsite availability, competition.

Maintaining semi-natural grasslands: what is the role of below-ground food webs?

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Interactions between plants and soil organisms are important regulators of plant community composition. Despite this, restoration of species-rich grasslands often only addresses changes in plant community whereas changes in soil receive little attention. We established a three-year study to investigate how mowing (no mowing vs. mowing once vs. mowing twice in a summer) as a restoration tool affects plants, in particular threatened species, but also the abundance of soil organisms and soil nutrient availability, in two different species-rich grassland plant communities. Our aims were 1) to get basic knowledge of the effects of mowing on plants and soil organisms that largely determine nutrient availability in soil, and 2) to understand how the above and below ground systems of grasslands are coupled. In addition to the field trial, we conducted a greenhouse experiment to study the effects of mowing-induced changes in soil on subsequent plant growth (i.e. the soil feedback). We collected soil from treatment plots at the end of the last summer of the field trial and followed the growth of seedlings of "wanted" and "unwanted" plant species in these soils. These results will tell whether mowing can create soil feedbacks that favour different plant species than the direct effects of shoot mass removal.

Keywords: Plant–soil feedback, soil food web, plant functional groups, species-rich grassland, restoration.

The ecological restoration of island wetland in Sanjiang Plain

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Sanjiang Plain is the largest marsh in China, which is formed by the Helong River, Shonghua River and Wushuli River. The nature wetland area reduced fast for human disturbance in the last decades. The island wetland was the main landscape type in Sanjiang Plain, which situated on high floodplain, low terrace and watershed of marshy river. The island's area was small(≤ 1km^2), biodiversity was rich, environment gradient was big, and sensitivity to environment change. The wetland was large-scale reclaimed for farmland. The farmland that reclaimed from island wetland was abandoned for its low yield, low topography, much water, low temperature. If the farmland was restored to island wetland, it would offered the habitat and "Stepping stones"for wetland wildlife. We chose the typical island wetlands (1km^2) of Sanjiang Plain as research sits, which was beside the Sanjiang Plain Marsh Ecological Experiment Station. After natural restoration for about 5 years, despite the severity disturbance around the island wetland, there were 30 birds nested here, such as *Phasianus colchicus*, *Anas platyrhynchos, Emberiza aureda*, *Circus melanoleucus et al.*, 37 beast, 8 amphibians, 5 reptiles,34 soil animals. So it is necessary to restoration of island wetland in farmland in Sanjiang Plain.

Keywords: ecological restoration; island wetland; Sanjiang Plain.

Wetland variation and restoration strategies in Sanjiang plain

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Sanjiang Plain is located in the eastern area of Heilongjiang province, an alluvial plain formed by Wusuli River, Heilong River and Songhua River, scattered the largest marsh wetland area in china. There are many perturbation factors which act on the Sanjiang Plain wetlands, including climate, fire, irrigation and drainage ditch, inning, grazing *et al*. Climate revealed a trend of less rain and a little high temperature by the analysis of fifty data, which resulted in the lack of water resource in the Sanjiang Plain. Fire is an important factor, it can burn up reed and even destroy the reed root, further destroy the habitat of rare water fowl and lead to the land salinization where fire touched. Farming and grazing activities were very common in the Sanjiang Plain, more and more hydraulic works and roads were constructed, so fragmentation of wetland landscape was obvious. Habitat of wetland flora and fauna was threatened, the loss of biodiversity was obvious. According to the actuality of Sanjiang Plain, a few measures must be taken to prevent the inning of wetland from happening further; flood resources should be utilized to the full, at the same time, based on watershed as a unit, resource exploitation, flood-control works and wetland protection should be managed as a whole; the management of natural reserve should be enhanced, fire should be put an end. wetland scientific research should be strengthened, wetland ecosystem monitoring and assessment should be developed greatly.

Keywords: Sanjiang Plain, wetland area.

Soil nematodes as focal species in restoration processes of the Guadiamar River (Southwestern Spain)

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After the mining accident occurred in April 1998 in the Guadiamar River (SW Iberian Peninsula), soil nematodes collected from selected experimental plots were studied along five years (2000-2004). The plots were located in the affected area, which became later the Green Corridor Protected Landscape. Throughout this period, the occurrence of mononchid (order Mononchida) and dorylaimid (order Dorylaimida) species was monitorized, paying special attention to variation of species richness and turnover ratio. An incipient restoration process was detected in most plots since 2001, but it was very distinct in 2003, with significant increase of species richness and turnover values. In local areas this process was observed even before these dates because of early experimental reforestation labours. The plots close to origin of toxic spill are characterized by their very low species richness values: some very frequent cosmopolitan species such as *Aporcelaimellus obtusicaudatus* were absent during the first year of this study, but present after 2001 when the first stages of restoration process took place. A similar pattern was observed for *Ecumenicus monohystera* and *Mesodorylaimus ibericus,* whereas *M. bastiani, M. litoralis* and *M. baeticus* appeared only in earliest restoration stage, when turnover occurs. Other species, for instance *Mononchus aquaticus* and *Mylonchulus sigmaturus*, were also found after 2001, but their presence was more fragmented spatial and temporally, almost always in association to riparian wetlands; on the contrary, *Clarkus papillatus, Coomansus parvus* and *Prionchulus muscorum* settled later.

Keywords: Soil nematodes, focal species, restoration, Green Corridor, Guadiamar River, Spain.

Restoring riparian biodiversity on agricultural land in South Eastern Australia

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In Australia, the relatively recent arrival of intensive agriculture has resulted in extensive land clearing which has had serious impacts on native biodiversity. Degradation of riparian areas on agricultural land has been particularly significant, but recognition of the importance of healthy riparian areas for both biodiversity conservation and water quality outcomes has led to widespread acknowledgment of the need to restore riparian communities. As the first stage of the restoration process, many land management agencies are advocating the fencing of riparian areas to prevent stock accessing waterways and damaging riparian vegetation. However, land holders are seeking verification that riparian fencing has a positive impact on biodiversity. A project has been undertaken in Victoria, south eastern Australia, to quantify

aspects of both the riparian and in-stream biodiversity on dairy and beef farms, comparing fenced sites with unfenced (actively grazed) sites. Standard survey techniques were used to assess riparian vegetation, small mammals, frogs, birds and aquatic invertebrates at each site. Fenced riparian sites were found to have greater native biodiversity than unfenced sites, with fencing having significant positive impacts on abundance, richness and diversity of many flora and fauna groups, including small mammals and birds. Relationships between habitat quality, trophic responses and faunal abundances were also found. This project has improved the understanding of the impact of fencing on riparian biodiversity on dairy and beef farms, providing evidence for improved biodiversity outcomes. It has demonstrated that fencing is an important component of the restoration process of riparian areas on agricultural land.

Keywords: Riparian, biodiversity, fencing, agricultural land.

Do floodplain meadows require restoration following a change of the hydrological regime? Preliminary study

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Within the river-floodplain ecosystems, many important projects (dishes, dams, river renaturation...) may permanently change the hydrological conditions. Experimental studies are needed to estimate the impact of such modification on meadow vegetation. For that purpose, 8 square samples (top soil layer with plant cover) of 2 meadow communities (mesophilic and hygrophilic) were collected in the field (NE France) and submitted in lab to unusual hygrometry levels: 5-months of water saturation for the mesophilic community / 5-months of draining for the hygrophilic community. A decrease of plant diversity was observed for each treatment, resulting from different patterns of species response (decline, stagnation or increase). In addition, the soil seed bank of the 2 plant communities was analysed in order to detect species likely to appear after an important change of moisture conditions. In fact, the soil seed bank of the mesophilic community did not contain any hygrophilic species. In the same way, no mesophilic species were present in the seed bank of the hygrophilic community. This preliminary study suggests that following a modification of the hydrological regime: 1) meadow plant communities would be affected by a change in competitive balance between species, leading to a decrease in plant diversity, 2) the soil seed bank could not contribute to restore optimal plant diversity in the context of new hydrological features. The implementation of restoration measures could therefore be suitable. However, further research must be carried out *in situ* to better understand the impact of hydrological modifications on the long-term dynamics of meadow plant communities.

Keywords: floodplain medows, hydrological change, plant diversity, plant dynamics, restoration.

Effect of cyanobacterial inoculation on nutrient status and structural stability of a semi-arid saline sodic soil

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Two heterocystous cyanobacteria *Nostoc spongiaeforme* and *Nostoc linckia* isolated from salt-affected semi-arid soils of Hisar, Haryana, India, were mix batch cultured and inoculated into saline sodic soil (Exchangeable sodium percentage, ESP 28%, pH 9.0, Electrical conductivity, EC 9.0 dSm^{-1}) in greenhouse experiment. In the 240 day experiment with low soil water (15-20%) there was a significant increase in total organic carbon, total nitrogen and available phosphorus. Exchangeable sodium as well as electrical conductivity of the soil declined by 90 days due to algalisation. Algal proliferation was slow due to limited soil moisture but gradually algal growth decreased bulk density and increased hydraulic conductivity of the soil.. Water stable aggregates increased in percentage with a significantly higher ($P < 0.05$) mean weight diameter (MWD) in algalized soil after 240 days. The two mixed cyanobacterial species produce exopolysaccharides (EPS) in increased quantities in the presence of salts which play an important role in binding soil particles as well as improve soil porosity. Soil microbial activities increased as a consequence of cyanobacterial inoculation as evidenced by enhanced soil dehydrogenase, invertase and phosphatase activity. Plant growth and yield of pearl millet-wheat sequence in the soil improved in response to algal treatment. The study shows that indigenous cyanobacteria can be used successfully for ameliorating saline sodic soils even in water deficient conditions for sustainable agriculture in semi-arid tropics.

Keywords: cyanobacteria, Haryana (India), saline sodic soil.

Pesticide degradation potential of *Pseudomonas* isolated from contaminated semi arid tropical soils for their eco-restoration

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Extensive and indiscriminate use of organochlorine pesticides like Hexachloro cyclohexane (HCH) in tropical and subtropical countries for effective control of insect pests has resulted in widespread environmental pollution. The use of such pesticides has been banned or severely curtailed in many countries. Even after discontinuation of its use, the problem of residues of all isomers of HCH remains because of high persistence and inter-conversion of these isomers in soil. Insecticides in soil have far- reaching consequences as they disturb the delicate equilibrium between microorganisms and their environment. Bioremediation is a promising area which holds potential for eco-restoration of pesticide contaminated soils. In the present study the HCH degradation potential of *Pseudomonas morsprunorum* and *P.alcaligenes* was investigated. These bacterial species were isolated from HCH contaminated soils and were acclimatized to different concentrations of HCH in the laboratory for more than 2 years. Degradation occurred at a significantly high rate under aerobic condition in culture medium with acclimatized bacteria even at low HCH concentration of 1 µg/ml. The most recalcitrant ß isomer of HCH was also degraded effectively by both the species after acclimatization, more so by *P.morsprunorum*. Considerable attention should be directed towards exploitation of various bacterial isolates from contaminated soils especially to identify the induced changes at the molecular level. Such strategies can be usefully employed for eco-restoration of contaminated tropical and subtropical soils which harbour a large variety of microbial populations.

Keywords: pesticides, contaminated soils, eco-restoration.

Important factors for local ecotype selection in active re-seeding restoration applications

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The type of restoration application in degraded natural rangelands, will depend on the degree of degradation, mainly with regard to soil and vegetation condition. Degraded areas that are beyond the threshold of natural recovery due to a decrease in soil physical properties and vegetation deterioration, normally need active restoration interventions. This includes the disturbance of the soil surface or removal of undesired species to reduce the competitive effect of the existing vegetation. The type and degree of intervention will depend on the aim of restoration. One of the main aims of restoration in degraded arid and semi-arid rangelands is, to increase the grazing capacity for livestock production which includes the re-seeding or re-vegetation with local ecotype selected species. To facilitate seed germination and seedling establishment in extreme environments, the restoration practice should also include protection measures such as brush packing or any cover by other organic matter. The timing of re-seeding is dependant on the seasonality and mainly precipitation, especially in areas where rainfall events are erratic and unpredictable. Re-seeding of large degraded areas with specific ecotype selected species greatly depends on the availability of seed. This is a major limiting factor and contributes to the fact that seed, which are more available in large quantities for the establishment of cultivated pastures and can be purchased from commercial seed merchants, are usually used. These species may not necessarily be adapted for the specific restoration aim in the selected area and the quality, viability and purity of local ecotypes are often not very good. Restoration applications have to be implemented according to a predetermined plan and should include sound long-term management principles.

Keywords: Semi-arid rangelands, live-stock production, seed quality.

Seed dormancy and germination ecology of 14 *Carex* spp.–implications for prairie wetland restoration

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In the prairie region of the U.S., thousands of wetlands have been restored since the mid-1980s but the *Carex* spp., dominant in natural wetlands, are not readily returning. To restore the *Carex* diversity and limit invasion by exotics, native species will need to be sown. We studied the basic requirements for *Carex* seed dormancy break and germination for 14 species. We tested for germination in fresh seeds under a static temperature treatment – 35/30ºC, 27/15ºC, 22/8ºC, 14/1ºC, or 5/1ºC – or a move-along treatment

where seeds moved among seasonal temperature regimes. We also stratified seeds for 2 weeks or 1 to 6 months and then tested for germination. We found varied responses among the 14 species with respect to their dormancy state at maturity, the amount of stratification required for dormancy break, and their temperature requirements for germination when conditionally or non-dormant. Many species were able to germinate at 27/15ºC and 22/8ºC without stratification and gained the ability to germinate at 35/30ºC and 14/1ºC with minimal stratification but the germination percentages and rates varied. In general, the speed at which germination occurred could be improved greatly with stratification across all temperature regimes. Our results indicate that there are quite varied life history strategies even for species of the same genus common to prairie wetlands. Given the often extremely limited seed supply of native species available for restorations, restorationists must consider that some species will achieve greater germination percentages and faster germination when stratified while other species will show little effect.

Keywords: *Carex*, prairie wetland restoration, sedge revegetation strategies, seed dormancy and germination.

Fragmentation effects on species occurrences in semi-natural grasslands in Sweden

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Using a set of remnant semi-natural grasslands, chosen to be as similar as possible, but differing in size, patterns of species richness and composition were examined. Edge-to-interior relationships in species occurrences were of interest. Relationships between population sizes of four short-lived species, under demographic study, and the size and isolation of these remnant habitats were also investigated. The colonisation ability of the species was examined by seed sowing. There was no relationship between size of grassland fragments and overall species richness, species richness at different spatial scales, and abundance of some typical invader species or species characteristic of semi-natural grasslands. However, the results indicated that larger grasslands have a comparatively larger number of species in the edges, whereas the opposite pattern was found in smaller grasslands. The similarity in species composition between the edge and the interior of the pastures also increased with grassland size. These kinds of effects may be early signs of fragmentation effects, that in the future will result in species loss even if the present distribution of semi-natural grasslands is maintained. It is generally assumed that population size is related with fragment size, which is largely untested and may not be relevant for all species. Preliminary results show that population sizes of the two short-lived species, defined as habitat specialists, were positively related to fragment size. Population size increases were also positively related to fragment size for these two species. Results from seed sowing indicate that the species may be dispersal limited in the study area.

Keywords: Habitat fragmentation, semi-natural grasslands, species richness, fragment size, short-lived species.

The role of the seed bank in fen meadow restoration on reclaimed peatlands of Poland

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A lack of viable seeds in the soil and limited dispersal abilities of target species are identified as the main constraints in the restoration of species-rich meadows. In Poland, during reclamation, many peatlands, originally mesotrophic and permanently wet, were drained and transformed into grasslands. Those sites are classified as disturbed systems, due to often unpredictable water regimes and a large degree of soil degradation. We examined if seeds of fen meadow species, are still present in the soil seed bank after 50 years of drainage and if they can, potentially, support the restoration after top soil removal. We performed seed bank analysis with the seedlings emergence method. During degradation, the seed bank of the target vegetation is depleting and it is important to estimate how long it can support the restoration. We compared those results it also with the seed bank of a well preserved fen. In order to evaluate seed persistence, we calculated a longevity index, using databases records. We found hardly any viable seeds at 40 cm depth (10,5 seed per m^2), and 693 seeds per m^2 at 20 cm depth. We found in total 33 and 6 species at depth of 20 and 40 cm. In both cases only few species were dominating the seed bank and the target species were absent. The seed bank in the top soil layer was dominated (60%) by ruderal species

and *Juncus articulatus*. We concluded that the seed bank can not facilitate the re-establishment of the fen vegetation after top soil removal and other measures should be applied.

Keywords: fen, seed bank, top-soil removal.

Effects of the Swiss agri-environment scheme on biodiversity

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As in other European countries, agri-environment schemes were introduced as a response to the ongoing loss of biodiversity in agricultural landscape. In Switzerland, hay meadows under the agri-environment scheme (ECA hay meadows) are the most widely adopted political measure to conserve biodiversity. This study assessed its effect on biodiversity. In total, biodiversity was sampled in 42 hay meadows in three different regions, using a pair-wise comparison of ECA hay meadows with conventionally managed hay meadows. Biodiversity was estimated by assessing species richness of four taxonomic groups representing different trophic levels: vascular plants, grasshoppers, wild bees and spiders. ECA hay meadows had more species of vascular plants, grasshoppers, and wild bees than conventionally managed hay meadows but the number of spider species did not differ significantly. Furthermore the species richness of vascular plants and spiders was larger at the edge than in the center of a meadow and this was independent of management. The positive effects of the agri-environment scheme on species richness of our indicator groups did not vary between the study sites, except for the grasshoppers. We therefore conclude that the Swiss agri-environment scheme applied to hay meadows positively affects biodiversity. Therefore, the scheme should be maintained and farmers should be encouraged to engage in long-term extensive management. For spiders the current management restrictions are not sufficient, most likely due to inappropriate vegetation structure. Therefore, organisms which particularly depend on vegetation structure may be targeted with additional restrictions.

Keywords: agri-environment scheme, grassland, species richness, arthropods, vascular plants.

An experimental study using the soil seed bank for revegetation in a constructed area

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A comparative study to assess effects of soil seed banks as a seed input for revegetation was conducted, where mitigations is called for in conjunction with the power plant extension. Forest topsoil of seven plots, where extant vegetation differs in conditions and locations, was collected from the surface soil (A0 layer) after measurements were taken on the ground vegetation in each plot. A greenhouse experiment was conducted and monitored for two years to analyse the germination potential of soil seed banks. The forest topsoil was spread on plastic trays (0.7m^2 X 7trays) filled with a 5 cm layer of sterilized potting mix. Also, comparative experiments using forest topsoil and commercially obtained seeds on cut slope were conducted for evaluating effects of soil seed banks for revegetation including species diversity. A geo-textile method was constructed to reinforce the lower layer of slopes and a revegetation method including soil seed banks was attached on the upper layer by a hydro-spray machine. The results indicate as follows (1) 51% of the flora species were germinated from soil seed banks in a greenhouse experiment and (2) in cut slope, the ratio of revegetation was determined to be up to 49% of the extant vegetation, moreover invasion of ten tree species from adjacent places was found. It can be concluded that the use of soil seed banks would be effective to promote establishment of diverse vegetation. However, it behooves to continue monitoring on succession of vegetation and pursue revegetation with another method for ecological restoration.

Keywords: Soil seed bank, forest topsoil, ecological restoration, revegetation, species diversity.

Harvested peatlands in the Czech Republic: possibilities for restoration

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In the Czech Republic, peat has been harvested since the 18th century. The peat was, and partly still is, extracted in bogs dominated by *Pinus rotundata* Link., the endemic species to Central Europe. Two main kinds of peat extraction can be distinguished with different impact on the ecosystem: 1. block-cut min-

ing, practiced in the past, and 2. industrial harvesting, having been practiced in the past 50 years. The block-cut peatlands were mainly left to spontaneous succession and they regenerated well to stages close to the original ones. The majority of today harvested peatlands were deeply drained and reclaimed by afforestation. Some limited drained parts, which were left to spontaneous revegetation, have developed towards common birch-pine woodland without regenerating peat-forming process. Only rarely peatlands are recently managed to restore their hydrology and respective vegetation. Differences in plant composition and stand characteristics between spontaneously revegetated and technically reclaimed sites are described. It was concluded, if the respective hydrological regime is preserved or restored, a peatland has a chance to recover by spontaneous or assisted succession.

Keywords: spontaneous succession, peatland, bog pine, Czech Republic.

Management of wetlands along the Gulf of Finland migratory flyway

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Palolankuja II. Kuusankoski. Filand

The main objective of this project is to manage and restore altogether twelve Natura 2000 wetland areas and thereby secure favourable conservation status for specialized wetlands wetland-dependent species mentioned in the Birds and Habitats directives. These wetland areas are situated along the Northern Coastal Gulf of Finland flyway. Along this flyway, waterfowl and waders wintering in the southern part of the Baltic Sea and the coasts of the North Sea migrate in the spring to their breeding areas and in the autumn back to their wintering areas. The project areas along the flyway are internationally valuable bird-rich wetlands in which 35 species mentioned in the Annex I of the Birds Directive either rest or breed. Important species such as *Cygnus cygnus*, *C. columbianus* and *Mergus albellus* use them for resting. Among the breeding species there are *Crex crex* and *Botaurus stellaris*; in Finland, 10% of the population of the latter breed here. These areas are also important habitats for many plant and insect species. A major part of the *Leucorrhinia pectoralis* population in Finland and of the entire Natura 2000 network lives within the project areas. The favourable conservation status for wetland-dependent species of the Birds and Habitats directives, will be reached by the following measures: 1) Planning of the future management and use of the areas in wide cooperation between experts, local inhabitants and land owners. 2) Enhancing the openness of plant-invaded bird-rich bay areas and the diversity of habitats by various restoration and management measures, such as mowing and clearing. 3) Reduction of the numbers of small predators infesting the bird communities. 4) Monitoring the effects of these measures on the natural habitat types and the species of the Habitats Directive as well as those of Annex I in the Birds Directive and other regularly occurring migratory bird species.

Keywords: wetland areas, Finland, flyway, Birds and Habitats directives.

Evaluation of ecological consequences of Vistula Valley renaturalization

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The VEDI (Vistula Econet Development And Implementation) project entails a pilot approach, by using the LARCH computer model filled with local ecological data as an example of DSS modeling, in assessing the ecological impact of various (hypothetical) land use scenario's in the Middle Valley of the Vistula River in Poland. The Vistula River is the last large river in Europe, which has retained much of its natural characteristics in its middle stretch through the Mid-Polish lowlands. The objectives of VEDI project: 1) demonstrate the use and potential of computer modeling in assessing ecological impacts 2) introduce senior government officials and representatives of concerned NGOs and other organizations to scenario development as a vehicle for broad public discussion. Several scenarios of infrastructure and agriculture development were analyzed and compared to the scenario of Renaturalization the restoration of natural river with minimal anthropogenic impact and regaining water retention in the valley of Vistula. The "brave" vision of nature protection included several elements: 1) removal of dikes along the river, 2) removal of Wloclawek dam, 3) removal of some settlements in the flood valley, 4) extensive agriculture on meadows and pastures. The main effects of renaturalized scenario are: increased viability of typical forest and semi aquatic species, improved cohesion of habitat patches and eco connectivity in the valley.

Keywords: ecological modeling, landscape, eco connectivity, renaturalization.

Restoring native trees in the Cofee Estates of the Western Ghats, Southeern India

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Coffee farming is the primary source of income for millions of farmers across the tropical world and the mainstay in many national economies. Coffee serves as a prime source of foreign exchange earning. Coffee production also overlaps with many of the biologically richest regions of the world and can contribute both to their endangerment as well as to their protection. Given the right conditions, coffee production can be both economically and ecologically beneficial. Coffee estates can maintain and enhance biological diversity and ecosystem functions on farms and surrounding areas. Coffee is traditionally grown in areas originally covered by forest. Ideally, a canopy cover of diverse native tree species that conserves local and endemic biodiversity is incorporated into coffee production systems. In recent times, these native trees have been replaced by monocultural stands of silver oak (*Grewillea robusta*) that are being planted for their fast growth and high timber value. Coffee estates with native trees create a diverse landscape mosaic that serve as wildlife habitats and migration corridors between protected areas. Coffee estates with native shade-trees, also provide essential habitats for diverse communities of other tropical forest species. Recent research shows that local species diversity of beetles, ants, wasps and spiders on a single tree species (*Erythrina poeppigiana*) in shade coffee plantations approximates the arthropod diversity levels on single tree species sampled in undisturbed tropical forest. Traditional shade coffee systems typically rely on much lower chemical inputs than industrial plantations. This is because planting coffee among natural vegetation, or among trees planted for shade, fruit or timber, can reduce susceptibility to pests. Elimination of shade cover can cause significant impacts on various soil quality parameters. Research in Nicaragua in the late 1980s documented that, relative to traditional systems, significantly higher erosion rates occurred on renovated coffee plantations where shade had been reduced. This study also showed that shade coffee systems demonstrated higher levels of soil moisture and organic material. Nutrient cycling also reacts to changes in the shade cover in coffee. In Costa Rica's Central Valley, where rainfall can reach up to 2.5 meters annually, the leaching of soil nutrients into the groundwater can be significant. Within these high-rainfall areas, unshaded coffee loses nearly three times more soil nitrogen than shaded plantations. In general, shade coffee systems with native trees have been shown to be more conservative recyclers of nitrogen than unshaded plantations.

Keywords: coffee estates, native tree cover, biodiversity, restoration of native trees.

Conservation & Management of Bhoj Wetland in India

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Upper & Lower lakes, designated, as Bhoj Wetland are the wetlands of international importance. Upper lake basin comprises of a submergence area of about 31.0 sq.km. and a catchment area of 361 sq.km., whereas Lower lake basin comprises of submergence area of 0.9 sq.km. and catchment area of 9.6 sq.km. While Lower lake is surrounded on all sides by dense urban settlements, only about 40% of the fringe area of Upper lake has dense human settlement and the rest is sparsely populated having cropping as the major land use. Increase in anthropogenic activities in the catchment had resulted in environmental degradation of the lakes. An integrated management plan comprising of both preventive and curative measures were conceived and implemented during 1995-2004 for the ecological restoration of the lakes. The major action programmes include diversion of domestic sewage, improvement in solid waste management, fringe area protection, catchment area treatment involving creation of silt control structures across the feeding channels and creation of buffer zone of plantation, removal of silt accumulated near the confluence of feeding channels, removal of invasive aquatic weeds, installation of aeration units, etc. These action programmes involved the application of locally suited design solutions, low energy and low cost technologies for sewage treatment, application of ozone to improve water quality of the lake water which have become eutrophic. Environmental education cum awareness programmes and participation of stakeholders remained an integral part of the conservation programme. A Lake Conservation Authority was created to ensure post project management of the lakes based on wise use concept. The paper discusses in detail the action programme and the experience gained during project implementation.

Keywords: environmental degradation, lake basin, Bhoj Wetland, urbans settlements.

Creation of 3D geomigration model for unloading section of contaminated groundwaters from the Karachay lake to the open hydrographic network

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Karachay Lake is the biggest open storage of medium-level liquid radioactive waste in the world. Use of this reservoir as a waste storage leads industrial solutions to filter into the underground hydrosphere that resulted in appearance of contaminated groundwater halo around the lake stretching from north to south for 10 km. To carry out work on rehabilitation of the Karachay region and maintenance of healthy men's vital functions it is important to be able to give correct contamination value, to forecast its propagation and influence on the hydrographic environment. The main processes causing contaminants migration and diffusion in groundwater in the unloading section are: 1) convective mass transfer in the flow; 2) density convection; 3) diffusion transfer because of concentration gradient; 4) hydrodynamic dispersion; 5) physicochemical interaction with water-containing rocks; 6) radioactive decay of radionuclides. This paper presents a 3D Geomigration Model to Simulate the Discharge of Contaminated Groundwater from Karachay Lake to the Open Hydrographic Network and some prediction computations.

Keywords: program, hydrodynamic dispersion; convective mass transfer in the flow, radioactive decay of radionuclides.

Ecological restoration in the biosphere Reserve Ciénaga de Zapata, Cuba

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The Ciénaga de Zapata Biosphere Reserve covers 628,171 hectares. It is one of the largest and most important wetland in the West Indies region. This reserve shows a great diversity of ecosystems. The forest fires and the tropical storms appear to be the most important natural causes of destruction of the ecosystems of the Ciénaga de Zapata in the last decade. Another affectation are mangrove diseases, presence of invasives species of the flora and fauna, illegal hunting, cutting and fishering, as well as the over explotation of some resources. This reasearch carry out the evaluation of the enviroment problem througt inventories, remote sensing and GIS techniques, participatory approach of the local population and decisors and socio-economic studies of local communities. The list of flora and fauna was actualized, the enviromental perturbation and the conservation areas were identified and mapped, and a management plan for the ecological restoration have been implemented. The control of some invasive species, forest plantation and management in the affected areas, control measurement for erradication of illegal hunting, fishering and over explotation of natural resource, environmental education of local people and decisors are in progress. Step for reach a major link between decisors making, local people and natural resources is a target for the sustainable development and conservation.

Keywords: ecological restoration, Ciénaga de Zapata, invasive species, conservation, management plan, wetlands.

Quality assessment of the head-water stream network of an agricultural watershed. Proposals for its rehabilitation to limit nutrient exportation

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Head-water streams control nutrient exportation downstream. Riparian and in-stream processes (channel and hyporheic) govern nutrient retention in such ecosystems. Farming and agricultural practices represent the greatest non-point source of nutrients to rivers and frequently degrade and even eliminate the ephemeral drainage network. Therefore, related ecological processes are perturbed. In 2002-2003 we performed a nutrient export study on the Galbarra Stream (3rd order), a small watershed with intensive cereal use in the Ebro River Basin (Spain). We appreciate a remarkable N and P exportation to the River Ega related to crop over-fertilization. Our study deals with an assessment of the streams of that watershed to define the measures needed for their rehabilitation, especially those related with the improvement of nutrient retention. In 28 reaches of the network we characterize channel and riparian cross-sections, riparian vegetation, bed structure, stream velocity and flow, and performed an evaluation of habitat quality. The larger part of the first order network (ephemeral creeks) has disappeared for cultivation. Remanent streams present habitats with a moderate degradation (suboptimal-marginal quality con-

ditions). Channels are straight and deep; frequently they present eroded steep banks ($\alpha > 75°$) without vegetative protection; riparian zones are very narrow. To limit the exportation of nutrients we propose the restitution of part of the missing network (an enormous earth-water surface of interaction) and the rehabilitation of the remanent streams. Such actions would favour the recovery of landscapes and habitats with a high ecological value. Initially rehabilitation will focus on network geomorphology and physical structure of channels.

Keywords: Head-water streams, nutrient exportation, agricultural watershed, rehabilitation, stream habitat assessment.

An evaluation on the effects of rehabilitation practiced in the coal mining spoils in Korea

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The effects of rehabilitation carried out in several sites, which are different in elevation and kinds of plants introduced, were evaluated in viewpoints of species composition, species diversity and physico-chemical properties of soil. Black locust, pitch pine, birch etc. were introduced for rehabilitation. Species composition of the rehabilitated sites showed somewhat difference from that of the natural forests without any relationship to elevation of sites and kinds of plants introduced. But species composition of the sites, which were restored naturally, was very similar to that of the natural site. Korean red pine and birch were usually immigrated naturally in the coal mining spoils of lowland and upland, respectively. Species diversity of the rehabilitated sites usually increased. Degree of diversity depended on history of rehabilitation. Physico-chemical properties of substrate showed big differences compared with those of the natural sites. For example, substrate of the coal mining spoils showed strong acidic property and nutrient deficiency. Those physico-chemical properties of substrate hardly changed depending on the period after rehabilitation. Therefore, above mentioned results were hard to be interpreted as the successional changes and the practices did not realize an ecological restoration. New method based on the ecological information obtained from the natural environment equipped with similar condition is under experimental study in order to solve the problems.

Keywords: ecological restoration, rehabilitation, species composition, species diversity, successional change.

Identification of management targets after habitat change: the valuable role of comparative demography

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The spatial variability in the population dynamics of *Primula veris*, a perennial herb of Central and Eastern Europe, was studied in order to find out key processes for population trends associated to specific successional stages and management. Replicate populations in five different habitat types representing different degrees of closure (from totally open areas to forests) were monitored over two to four growing seasons in the Northern limit of its distribution range (Finland and Sweden). Matrix population models were used after assembling survival and fecundity rates. Analyses of proportional sensititivity (elasticitiy) of population growth rate to relative changes in vital rates suggested that the best method to manage decreasing late successional populations would be to increase survival of the largest individuals. However, this is really difficult because survival is already very high, so that these populations would not attain positive population growth even if they had no mortality at all. Comparative analysis on the actual variation in demography of the species over the different habitats (Life table response experiment analysis, LTRE) suggested, on the other hand, that survival of large plants contributed little to differences in population growth rates of different habitats. Restoration of recruitment through active management seems to be the best way to enhance population growth rate in late-successional populations, despite that recruitment was predicted as a process of low impact according to analysis based on individual populations. We conclude that both prospective methods, such as elasticities, and retrospective methods, such as LTRE, give valuable information in identifying management targets.

Keywords: *Primula veris*, successional gradient, matrix model, population growth rate, elasticity, LTRE, restoration.

Wood to Water: Short-term effects of the re-introduction of wood to streams in agricultural environments

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Rehabilitation of streams on agricultural properties has become a priority for landholders and managers in recent years in Australia. Fencing and re-vegetation of riparian zones are first priorities to improve riparian habitat values and biodiversity, however changes to in-stream habitat complexity are unlikely to result in the short term. Little evidence exists to guide subsequent rehabilitation actions to address this issue. Artificially re-introducing wood to such streams may be a useful strategy to increase habitat complexity more rapidly, thereby improving in-stream biodiversity values. To test this hypothesis, as a part of the larger Productive Grazing, Healthy Rivers project, small pieces of wood were introduced to eight sites on beef and dairy properties across southern Victoria, monitoring aquatic macroinvertebrates, water quality, hydrology and habitat quality. Comparing macroinvertebrate communities before and after treatment, and between experimental and control sites, changes in community composition and colonisation are explored.

Keywords: macroinvertebrate, wood, rehabilitation.

Using a polyacrylamide gel in a soil-forming matrix to re-vegetate a waste rock tip in Wales, UK

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Restoration and re-vegetation of waste rock tips can be problematic due to the inherently low organic matter, water holding capacity and nutrient content of the material, and associated high rates of weathering. The potential of polyacrylamide (PAM) water-absorbing gel for overcoming problems encountered when carrying out tree planting for restoration purposes on slate waste tips, will be tested at a quarry on the edge of the Snowdonia National Park, Wales, UK. It is proposed that a soil-forming matrix will be created using the PAM gel, processed slate fines, composted green waste, and pre-treated tree seeds. It is hoped that this combination of materials will provide sufficient water holding capacity, organic matter, and nutrients to allow relatively rapid and successful development of tree seedlings in a very harsh environment. An estimated 83% void volume exists in the surface 30 cm of a typical waste rock tip. The soil-forming matrix will be applied to the rock waste using hydro-seeding technology to fill the substantial interstitial spaces. This will allow easy, rapid and cheap application of a large number of tree seeds to a wide area. This will be one of a number of experiments carried out as part of a PhD project looking at the indicators of restoration success and the potential of novel restoration techniques on waste mineral tips in the UK.

Keywords: Restoration, rock tips, polyacrylamide, hydro-seeding.

Evaluating roadside restoration practices and plant composition in urban zones

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The practice of revegetation can play a vital role in restoring native vegetation to disturbed ecosystems such as roadsides. This study evaluated success of vegetation establishment on revegetated roadsides in Tucson, AZ. Species richness, origin, cover, density and structural diversity were measured for 25 distinct revegetation sites located along various roadways in Tucson, AZ. Comparisons were done between existing vegetation and specifications of the revegetation plan for the site. Results indicated that the majority of species established were not specified in the original revegetation plan. The presentation will focus on discussion of species composition for the sites and effective revegetation practices for establishment of native vegetation in this region. Recommendations related to appropriate practices and plant species for future urban development and remediation in Tucson will also be emphasized.

Keywords: revegetation, roadsides, native vegetation.

Removing human disturbance in the vegetated shingle habitat-Does it promote vegetation restoration?

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The vegetated shingle habitat is a rare resource subject to great recreational pressure in southeast England. This research examines the impact of trampling on the habitat and investigates whether protecting an area from human access is a useful way of promoting vegetation restoration on a shingle beach. At Cuckmere Haven East (Seven Sisters Country Park, East Sussex) a central region of the shingle beach was fenced off to human access in early summer 2004. The roped off region and the western adjacent unprotected area were divided into top beach, back slope and back flat regions. In July 2004, six randomly selected 1 m^2 quadrats were located in each region in both untrampled and trampled areas (n tot = 36). In each quadrat the number of species occurring, percentage cover and frequency, and maximum height were recorded. Six further quadrats, in both untrampled and trampled areas (n tot = 12), containing a high number of *Glaucium flavum* plantlings were also selected to look at young plant survival. A high resolution digital photo was taken of each quadrat and for each quadrat the area of every *Crambe maritima* and *G. flavum* plant was calculated using ArcView GIS 3.2. Identical measurements will be taken in July 2005. Initial data show that vegetation cover is sparse and consists mostly of *C. maritima,* however, many ruderals are also present. This presentation will examine and compare initial and final diversity and abundance data to identify any differences in vegetation cover after restricting access.

Keywords: *Crambe maritima*, *Glaucium flavum*, shingle vegetation, vegetation restoration, trampling.

Abiotic limits of two *Sarcocornia perennis* subspecies in Mediterranean Salt Marshes–Implications for restoration

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When undertaking the restoration of coastal marshes, either by transplanting or by facilitating the natural colonisation of certain species, it is essential to understand the relationship between environmental variables e.g. inundation period, pH, conductivity and redox potential, and species distribution, along a topographical gradient. Two subspecies, *Sarcocornia perennis* subsp *perennis* and *S. perennis* subsp *alpini*, occur in the salt marshes of the southwest Iberian Peninsula. These subspecies occupy contrasting habitats and play important roles in the marsh structure. To characterise the fundamental niches, in relation to the aforementioned variables, a transplant experiment was conducted at four points situated along the tidal gradient. After 5 months clumps of S. *perennis* subsp *perennis* survived at levels between 2.26-2.84 m SHZ with soil redox potential between -160 and 110 mV at the surface, 7.6 and 7.9 at depth; and conductivities between 13.4 and 15.8 mS cm^{-1} at the surface, and 12.1 to 14 at depth. *S. perennis* subsp *alpini* only survived at levels higher than 2.84 m SHZ, where soil redox potential was between 114 and 170 mV at the surface, and -26 to 206 mV at depth, soil pH was between 6.7 and 7.1 at the surface and 6.7 to 7.6 at depth and conductivity was between 11.1 and 15.8 mS cm^{-1} at the surface, and 10.4 to 14 at depth. The lower ranges of *S. perennis* subsp *alpini* and the lower and upper ranges of *Sarcocornia perennis* subsp *perennis* appear to be limited by abiotic factors but it is unclear what limits *S. perennis* subsp *alpini* at its upper range.

Keywords: Coastal salt marshes, fundamental niches, transplant, abiotic factors, *Sarcocornia perennis.*

Systematic analysis of the morphological evolution of central reach of river Ebro in the last 100 years. Lessons and recommendations for its ecological restoration

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Central reach of river Ebro has suffered, throughout the last century, an important morphological evolution. Increase in its hydrological regulation and changes in land use have accelerated and modified largely the natural evolution of the river, as it is possible to extract from the analysis of its main hydromorphological variables. Good ecological status of river ecosystems is essential, both from a socioeconomic focus, given its importance for different communities, and from a merely environmental approach. Analysis of this morphological evolution, decade after decade, since 1890 to this date, allow us to establish a range of

recommendations for its restoration, including all different sides which turn this river into one of the most important in the national and European level. Conclusions of this work are, at the same time, of interest for the accomplishment of standards imposed by Water Framework Directive. This fact is specially clear when taking in hand that a very long reach was used for the analysis (ca. 103 km), in order to obtain data and recommendations in accordance with the core of the new legal framework, which holds tightly a holistic management of basins. Final results are also very important for the planning of necessary advances in the analysis of a number of strategic subjects related to the different variables involved in the fluvial environment, that may be the key for the successful management of these systems.

Keywords: river restoration, fluvial morphology, morphological evolution, Ebro river.

Ecovars 2: an interdisciplinary project for ecological restoration in French Pyrenees

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Ecovars 2 has been elaborated to extend and enhance the project developed by the Pyrenean Botanic Conservatory during 7 years about restoration of damaged sites in the Pyrenean mountains. The aim of this project is to promote the use of native species in land reclamation. This project gathers different types of structures in order to carry out simultaneously: 1) The centralization of information and the organization of a collective work about ecological restoration in the alpine and sub-alpine Pyrenees; 2) The development of agricultural aspects of native seed production with farm experimental multiplication; 3) The finalization of genetic studies, with a work on adaptation of plants to local environment; 4) A collective reflection in a scientific workshop in order to define "collect and use" zones for the species produced and used in land reclamation; 5) The monitoring of a seed production and of the certification process by a sociological analysis. Ecovars 2 (2005-2007) is a French inter-regional project which concerns mountain damaged sites all along the Pyrenees. It is financially sustained by Europe, French State (inter-regional massif convention), Languedoc-Roussillon, Aquitaine and Midi-Pyrenees Regions and winter sports resorts (N'Py). This poster presentation aims at binding contacts between different structures, especially in Spain, to establish a trans-Pyrenean dynamics and network.

Keywords: Mountain damaged sites, land reclamation, interdisciplinary project.

Functional and structural diversity of soil microbial communities on Colliery Spoils Heaps

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The aim of this study was to determine important environmental factors influencing functional (Biolog System) and structural diversity (PLFA, ARDRA) of the soil microbial community during primary succession on non-reclaimed post-mining sites, near Sokolov, Czech Republic. Four successional stages were observed: The initial stage (0-1 year) was represented by freshly heaped spoil substrate with compact non-weathered clay stone. The herbs appeared in early stage (10-11 years). The mid stage (19-20 years) was characteristic with rapid development of herbal as well as shrubs vegetation and accumulation of litter and millipedes excrements in the massive fermentation layer. The late stage (42-43 years) was covered by well developed vegetation with tree species with a thinner fermentation and well developed humus layer. The microbial community of the initial stage was influenced by pH and the clay content. The herbs cover was the main controlling factor of the early-stage-community. The woods were found as the most important factor influencing the mid- and late-community. The zooedafon significantly influenced the structural but not functional diversity during primary succession. The laboratory microcosms experiments with plants and with various types of litter and zooedafon-decomposers confirmed above mentioned hypotheses. Soil animals affect more structural than functional diversity and on the contrary the plants were more important for functional than for structural diversity.

Keywords: soil microbial community, Czech Republic, environmental factors.

The Mechanical removal of water hyacinth (*Eichhornia crassipes*); Is it a good politic of restoration? The case of a Mexican reservoir

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The Valsequillo reservoir, located near the city of Puebla, Mexico, has been infested with water hyacinth for over three decades. A government management program involving the use of triturating machines was applied in tree different times from December 1996 to January 2004. After each trituration, remains were allowed to settle in the bottom. The purpose of this research was to monitor the changes in the water quality and the biological communities before and after physical control of weeds. A monthly sampling of surface water was performed at four stations one year before the treatment. After trituration, some years sampling were also carried out. Weed control affected changes in all variables measured, as a result of residual decomposition of triturated matter. Secchi transparency and oxygen levels decreased and pH became slightly more alkaline. More important changes occurred for nutrients. Orthophosphate concentration increased, for nitrate and nitrite increase was about 320% and 450% respectively. Ammonia reached lethal values for at least four months after trituration. As a result, phytoplankton decreased initially, and when it flourished again, the Bacillariophyta was replaced by Cyanophyta. Chlorophyta was important in all years. Of zooplankton, calanoids decreased, but cyclopoids and cladocerans maintained similar numbers, however the latter group changed in composition so that *Ceriodaphnia* was replaced by *Moina*. Fish disappeared from the system after weed trituration. In the second year a small recovery of water quality occurred, but water hyacinth also started to develop again. Nowadays, Valsequillo is again covered by water hyacinth.

Keywords: weed control, plankton, nekton, freshwater.

Evaluation of seed bank composition as a tool to assess the restoration potential of *Acacia longifolia* invaded ecosystems

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Many natural and semi-natural habitats are presently being invaded by exotic plants, resulting in increased degradation of indigenous ecosystems all over the world. *Acacia longifolia* (Andrews) Willd. became invasive in Portuguese dune ecosystems, developing into an environmental threat of alarming proportions. Successful restoration of invaded habitats, including the re-establishment of indigenous species, depends not only on abiotic conditions but also on seed availability. The emergency method assesses the amount of viable seeds but may not reveal seeds whose dormancy breaking requirements are not met. These may be disclosed by the flotation method, which in turn renders difficult the determination of seed viability. Our study combines both methods allowing more precise seed-bank quantification, which in turn is paramount to accurately determine the system's ability to restore after the removal of invasive species. For this study, *A. longifolia* long invaded and recently invaded areas were selected. The invasive species were removed and different treatments applied. Control plots were installed in areas without *A. longifolia*. Soil samples were collected in order to evaluate the impact of *A. longifolia* on the native seed bank. Results indicate that seed abundance and species richness are higher in recently invaded areas. *A. longifolia* seedlings are more frequent in long invaded areas. The later are so depleted that artificial seed supply of indigenous plants may be needed. Seeds of *A. longifolia* are present even in the control plots. The use of only one method would have lead to incomplete information about the real species diversity and abundance status. Hence, coherent restoration planning would benefit from the coupled use of these two methods.

Keywords: seed-bank, emergence/flotation methods, invasive species, restoration.

Planning the restoration of biancane cultural landscape with object-oriented image techniques

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The Natural Reserve of Lucciola Bella, located in the Orcia valley (southern Tuscany, Italy) safeguards the peculiar cultural landscape of biancana badland, i.e. erosion forms generated on Plio-Pleistocene sea clays outcrops. Human intervention (e.g. fire, grazing practices) in historic times is responsible for the intense runoff that created those forms. In more recent times, abandonment of traditional activities and mechanical innovation altered the balance achieved in those territories. As a consequence, following the natural process of re-vegetation, shrubs are occupying the last biancane, threatening the conservation of the cultural landscape and the biodiversity within. Although measures need to be taken to maintain this vanishing landscape (e.g. shrubs cutting, grazing and the use of fire), a proper planning is necessary to pursue the equilibrium between erosion and shrub encroachment. We present a methodology, based on an object-oriented image classification of multi-temporal aerial photos (1954-2002), to obtain an objective and repeatable procedure to identify meaningful planning units to restore and rejuvenate the biancane landscape and arrange long term conservation activities in an environment highly exposed to erosion.

Keywords: restoration planning, cultural landscape, biancana badlands, erosion, object-oriented image classification.

Restoration of Atlantic rain forest in Southern Brazil: the role of the natural regeneration

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The Atlantic Rain Forest in the Brazilian Coast is one of most diverse biomes around the world and one of hotspots for conservation. In the last century, the expansion of cities and agriculture have strongly reduced this forest in the Southern Brazil. This impact caused a fragmentation and efforts to connect forest fragments are important to restore the ecosystem. We compared seed rain, seed bank, seedling establishment, plant phenology and plant community structure in young (~4, 10 and 24 months) and old (~8, 25, 45 years) vegetation to verify if natural regeneration is sufficient to recover the structure and diversity of the disturbed areas. This is a long term study carried out since 1998 and consist of several experiments to test a variety of effects. Our general results show that 1) seeds arriving from close forest fragments are essentials to improve plant diversity and abundance; 2) seedling and sapling establishment depends on intensity and type of soil management; 3) successional process recover the main functions (e.g. diversity, structure and dynamics) of plant communities.

Keywords: seed rain, seedling, sprouting, succession.

Life-form succession in plant communities on uranium-mining wastes: insights for ecological restoration

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We analysed changes in plant cover and species richness along a 16-year chronosequence in a semi-arid Mediterranean uranium mine of centre-western Spain. The objective was to test whether Raunkiaer's life form showed different patterns along the abandonment gradient. During spring of three consecutive years we sampled 34 slopes (37º incline), in which mining waste was covered with finer textured sediments, and that underwent a natural revegetation process. On each slope, eight quadrats of 50 x 50 cm were randomly sampled taking up all the vegetation heterogeneity. The species cover (%) was visually estimated in each quadrat. The results suggest that cover and richness of different functional groups show significant differences between mining-waste age groups. Therophytes were the most abundant for all ages, but their cover decreased significantly from the 12 years. Hemicryptophytes were the second group in importance which increased from the sixth year. Geophytes were the lowest represented group, being more important for the period 3-5 years. The presence of phanerophytes and camephytes seemed not to be related with time but to other site characteristics such as plantations. It can be concluded that spon-

taneous succession promotes establishment of diverse vegetation, being higher the contribution of therophytes in the study area, and existing a negative correlation between those and hemicryptophytes.

Keywords: ordination, functional groups, semi-arid Mediterranean climate, spontaneous succession.

Restoring tropical forest in pastures under natural succession: Growth rates of late-successional tree species under different light microhabitats

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In tropical sites where dispersal of forest seeds is low or nil, abandoned lands may remain with no forest cover for a long time. In such cases, erosion degrades land quickly, making future restoration efforts difficult. In such cases, plantation of forest species is needed to assist the process of natural succession. However, little is know about the performance of late-successional species in those places. Here we show growth rates of 12 late-successional species in sites close to Los Tuxtlas Biological Station in Veracruz, Southeast Mexico. Incoming vegetation was cut once a month to simulate arrested succession for 17 months after planting. For the next 15 months, individuals growing under secondary forest, gaps or pastures experienced a decrease, increase or a similar light level as the plantation was left to undergo natural succession. Individuals had indistinguishable growth rates in diameter and height irrespective of the previous light level they experienced ($F(2,91)= 1.19$, $P < 0.5$ and $F(2,94)=0.85$, $P < 0.5$ for diameter and height respectively). Individuals showed significantly higher growth rates in diameter (0.05 ± 0.02 mm mo^{-1}) and height (3.6 ± 0.5 cm mo^{-1}) in pastures conditions than in secondary forest (0.02 ± 0.002 mm mo^{-1}, $F_{(2,91)}= 8.23$, $P < 0.0005$ and 1.8 ± 0.2 cm mo^{-1}, $F_{(2,94)}=9.22$, $P < 0.0002$ for diameter and height respectively). Late-successional species growing in pastures for long time showed higher growth rates than in secondary forest. Late-successional species can be planted in pastures to bypass the species-poor early stages of natural succession.

Keywords: arrested succession, late-successional species, Los Tuxtlas, tropical forest.

Preliminary appraisal of the re-vegetation potential of a proposed mine in the Northwest Territories, Canada

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A preliminary trial to determine the effectiveness of vegetation transplantation activities commenced at the NICO property in September 2004. NICO is a near-surface gold deposit with by-product cobalt, bismuth and copper located approximately 160 km north-west of Yellowknife in the Northwest Territories of Canada. The trial was undertaken to transfer technical skills from Golder biologists to Fortune Minerals staff and to provide site-specific scientific data for restoration activities associated with preliminary decommissioning plans of the proposed project. The methodology for the preliminary trial involved selecting a species (*Antennaria rosea* Greene) that was considered likely to be negatively impacted by the proposed development. *A. rosea* does not possess any official designation (e.g., rare or endangered); however, the species was not encountered at any other location during baseline studies. Genets were divided from the grouping and transferred to a site outside the footprint of the proposed development but within 2.5 kilometres of the origin site. Both sites will be subjected to similar environmental factors and should provide data over time relating to the effect climate change may have on the success of potential restoration activities involving transplantation. If trials prove successful, the transplantation site has the potential to act as a temporary "holding site" for progeny of the transferred genets, which may ultimately be utilized for restoration on the property. This poster will present the results for the first year of growth and survivorship monitoring, and will detail the upcoming efforts to develop proven scientific knowledge for restoration in disturbed northern environments.

Keywords: *Antennaria rosea* Greene, vegetation restoration, Northwest Territories, mining.

Combating storm water impacts on restored ecological communities nested in an urban landscape

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1800 million liters per year of urban storm water runoff passes through the University of Wisconsin-Arboretum. The Arboretum is a 510 hectare collection of restored ecological communities completely surrounded by an urbanized landscape. Impacts upon the communities include high levels of phosphorus in surface water, sedimentation of wetlands and mesic prairies, erosion of upland terrain, and the establishment and spread of invasive species. Comprehensive watershed-based storm water management planning, combined with innovative storm water management practices and outreach education, have provide valuable tools for restoration of damaged landscapes, and the prevention of future degradation. The approach engages the scientific and educational expertise of the university in partnership with community groups, municipalities and the business community.

Keywords: storm water, phosphorous, urban ecology, invasive species.

Effects of a CO_2 enriched atmosphere and an increased temperature on the nursery production of Mediterranean tree species for restoration projects

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Plants needed for restoration projects in Mediterranean-type environments must be plants pre-adapted to harsh environmental conditions. This resistance can be previously conditioned in the nursery by certain cultural practices ("hardening"). However, these treatments may also reduce the productivity of the nursery by reducing the growth of seedlings. Therefore, new nursery treatments should be designed to improve both targets: higher plant quality and nursery productivity. In this study we have evaluated the combined effects of different treatments of a nursery $C0_2$ enriched atmosphere and an increased temperature in the growth, morphology and root growth potential (RGP) of seedlings of four Mediterranean tree species (*P. nigra*, *P. pinaster*, *Q. ilex* and *Q. humilis*), extensively used in restoration projects in the Mediterranean Basin. The use of a $C0_2$ enriched atmosphere and an increased temperature enhanced the productivity of the nursery by speeding up the growth of seedlings. Moreover, seedlings grown under this treatment showed a higher concentration of N and carbohydrates in the roots, and a higher capacity to produce new roots (RGP) when transplanted. Nevertheless, this treatment had contrasting effects in the biomass allocation model of the species studied: root-shoot increased in the two pine species (*P. nigra*, *P. pinaster*) while decreased in the oak species (*Q. ilex*, *Q. humilis*). Therefore, the use of a $C0_2$ enriched atmosphere and an increased temperature during the nursery stage may be viewed as a promising technique to increase both the productivity and seedling quality of Mediterranean pines, but it might be not so appropriate for growing Mediterranean oaks.

Keywords: hardening, nursery productivity, root-shoot, root growth potential.

Encouraging the regeneration of the biodiversity through zoochory in Sierra Nevada (SE Spain)

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The traditional restoration of many degraded Mediterranean forests has been based on the direct management such as clearing and planting trees and shrubs, with little attention to plant-animal interactions. Within such interactions, seed dispersal by animals is a limiting factor in recovering the biodiversity of woody species. Ecological restoration may seek to create a habitat structure attractive to dispersers in order to encourage natural forest regeneration. Our aim is to quantify seed dispersal as well as frugivorous-bird abundance and diversity in response to habitat attractiveness of different landscape units. The ecosystem under study is the autochthonous *Pinus sylvestris* forest of Sierra Nevada National Park (SE Spain), fragmented by human activity and partially replaced by two different degraded landscape units: 1) post-fire successional shrublands and 2) reforested pine stands with three degrees of management (control, fencing, and clear-cutting). The methods used were bird census, seed traps, and monitoring of seedling emergence. The results show the autochthonous forest is the landscape unit with largest

diversity and abundance of seed-disperser birds, and for the degraded landscape units, bird diversity and abundance increases with clear-cutting. The presence of bird-dispersal seed rain in the reforestation stands points out the importance of frugivory in the input of woody-species seeds, as shown by the successful establishment of the seedlings of these species. We can conclude that the ecological restoration based on the plant-animal habitat attractiveness is an effective way of improving the recovery of the biodiversity.

Keywords: plant-animal interactions, seed dispersal, woody-species biodiversity, regeneration.

Functional strategies of grassland species for grazing persistence: a new model

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Species characterization related to functional-morphological traits allows the reduction of taxonomic variability. In this study we present a model to classify grassland species in plant functional types according to their response to three different strategies of persistence: reproductive, vegetative or defensive. These strategies are characterized considering the morphological and functional traits of the species. The model is based on the following axiom: in grazed grasslands, the recovery and persistence of a particular species is only possible if increases its reproductive ability (reproductive strategy), its growth ability (vegetative strategy), or its ability to avoid predation (defensive strategy). This model can be described by: Rb = Pr + Pv – Pd, where Rb is the capacity of persistence, Pr the reproductive potential, Pv is the growth potential and Pd the defensive potential. Plant functional types result from the species classification by these three types of potentials. The underlying hypothesis is that as frequency and intensity of grazing increase, at least one of these plant persistence strategies should be high. To verify this hypothesis we test the response of plant functional types to a stocking rate gradient in grassland communities of the Espinal agroecosystem, in the Mediterranean zone of Chile. Plant responses to an intensification gradient provide a critical feedback to adequate restoration practices in abandon or overgrazed land use scenarios.

Keywords: plant traits, functional groups, ecosystem function, grazing, land use.

Coastal dune regeneration in the Urdaibai Reserve of the Biosphere (Southern Bay of Biscay)

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As a consequence of the erosional character of the Cantabrian coastline with extensive cliffs, coastal dunes represent a very scarce ecosystem on the southern Bay of Biscay. The dominant wind direction and, therefore, the wave attack are from the northwest, and these cause sand to be transported onto the eastern margin of the estuary mouths where it forms small beaches and dunes. This process has operated for at least 6000 years. Following destruction and intense transformation of these sandy areas during the last 200 years and due to their important role in coastal protection and biodiversity conservation, preservation and regeneration of these unique ecosystems has become of great social interest. The Governing Board of the Urdaibai Reserve of the Biosphere decided to regenerate the coastal dune field that existed until 1950s on the lower estuarine area. In order to achieve this goal, a three-year geological study has been implemented to identify and evaluate the different physical processes operating in the area. An integrated sedimentological, metereological and biological monitoring study has been carried out. Sandy accumulation takes place only from October to March every year due to the seasonal wind regime. Total volume of sand accumulated during the study period was 12,200 m^3. The obtained results have contributed to the success of the regeneration programme, to a correct management of the sandy lower estuarine environment (e.g. periodical dredgings), and to the support of this initiative through a Life-Nature project from the European Union.

Keywords: coastal dune regeneration, geological study, Urdaibai Reserve of the Biosphere, Bay of Biscay.

Arbuscular mycorrhizal hot spots for the ecological restoration, one case study in a semiarid scrub in Mexico

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The arbuscular mycorrhizae play an important role to achieve establishment of plants in disturbed areas, for it to detect sites with high mycorrhizal diversity and nutrients (hot spot) is key tool for restoration programs. This work detected the hot spots of arbuscular mycorrhizal fungi (AMF) in a semiarid scrub at the Mesquital Valley, Mexico. To study the AMF, 10 composite soil samples were collected under and outside of the Mesquite (*Prosopis laevigata*) canopy in two sites (disturbed and undisturbed) of a semiarid scrub. Composite soil samples were used to make AMF quantifications, analyses soil chemical and a greenhouse experiment. We found that, in both sites, the Mesquite fertility islands were a hot spot important of AMF, with 4400 spores, 18 morphotypes and 6 species present only in fertility islands. In disturbed conditions these Mesquite hot spots are who mainly favor the diversity and number of AMF, and increases in soil the carbon and nutrients concentrations in comparison with soil without the mesquite effect. Also, results of an experiment in greenhouse suggest that the AMF inoculums coming form Mesquite hot spot benefit the morphology and phosphorous nutrition of a pioneer plant: *Bouteloua curtipendula*, until obtaining resistant individuals (shorter stature, more underground biomass, less tillers of more diameter and less leaves number of more area and mass) for revegetation programs. In conclusion, the fertility islands are hot spots with significant ecological importance as nutrients and mycorrhizal propagules dipersion centers, therefore they should be considered in the restoration of the semiarid scrub disturbed.

Keywords: Semiarid scrub, ecological restoration, hot spot, arbuscular mycorrhizal fungi, soils.

Vegetation succession on reclaimed opencast coal mine slopes in a Mediterranean – Continental environment: the Teruel coalfield, Spain

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The opencast mining of coal (mineral that feeds the 40% of world energy production) represents an activity with a very high capacity of landscape transformation. The restoration of areas affected by this activity implies serious difficulties because of the intensity of its impacts. In order to improve the ecological restoration operations, this study, carried out in the Teruel coalfield, analyzes the trajectories of ecological succession and its control factors on reclaimed artificial slopes from the opencast coal mining, taking into account the conceptual basis of the new paradigm of ecology. A series of 87 slopes of different ages and applied treatments were classified (by means of TWINSPAN analysis of vegetation) and characterized. Successional tendencies are inferred from indirect gradient analysis (DCA) as well as the factors, mechanisms and processes involved. The divergent successional pattern found in the investigation is described within. A set of deterministic and contingent and/or eventual factors are involved in this pattern. Some different processes and mechanisms are related to the different trajectories: physical and chemical restrictions and soil cover toxicity, distance from the propagules sources, inhibition from initial non-native seeded herbaceous vegetation, the effect of disturbances (grazing and fungical diseases on vegetation) as well as erosion. The soil erosion is one of the main processes related to the failures of mine restoration; in Mediterranean-continental environments it could affect the vegetation development and succession through the increase of natural water deficit for plants. Finally, a conceptual adaptative strategy for restoration works is proposed, which includes not only initial conditions and environmental restrictions, but also surrounding ecosystems, human activities, disturbances and other contingencies.

Keywords: Acidity, contingency, DCA, disturbance, ecohydrology of artificial slopes, ecological restoration, ecological succession, erosion, inhibition, Mediterranean-Continental climate, new paradigm of ecology, opencast coal mining, propagules availability, Teruel, TWINSPAN, water deficit.

Hydrologic and social factors limiting the restoration of Monreal Springs (NE Spain)

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Ecosystem restoration uses to be limited by a range of factors which range from physical characteristics to management issues. Hydrologic constraint is the most common limitation for wetland restoration. The restoration of Monreal Springs (a groundwater fed wetland in the Jiloca riverside, NE Spain) is taking place based mainly in recovering water level and natural water flows which were disturbed because of sediment accumulation and water diversion for irrigation purposes. Recovering water level took place in small experimental areas of the wetland through lowering soil surface in small areas and increasing the water stored in the wetland during short periods of time. These restoration practices resulted in an increased plant biodiversity and decreased detritus accumulation in these areas compared with non-restored zones. However, implementation of these restoration practices at whole wetland scale requires agreement with wetland users, water authorities and users. A survey was used to know people's preferences and availability for the restoration. Wetlands users showed clearly preferences for natural restoration of the whole wetland. A working agenda was developed to integrate water users in the restoration process, which concluded with agreements for recovering water flows for the restoration of Monreal Springs and establishing an on purpose water regime. Social availability has arisen as a major limiting factor for wetland restoration which requires to be fulfilled before other physical factors.

Keywords: social, economy, hydrology, springs, rural, restoration.

Defining riparian restoration goals in a Pueblo Indian community

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Much of the floodplain forest and wetland along the middle Rio Grande in New Mexico, USA has been occupied by Indian tribes for centuries. Their participation is now crucial in restoring the river after severe alteration by channelization, cessation of flooding, geomorphological disruption, lowered water tables, invasion by non-native trees, and wildfires. Floodplain forest/wetland restoration at San Juan Pueblo, one such tribal community, began in 1999 with limited funding and poorly defined reference conditions. As the project expanded to plan for restoring over 700 hectares of floodplain ecosystem along 16 kilometers of river, it became urgent to articulate both cultural and ecological restoration goals beyond "returning to natural conditions". This paper explains how restoration ecologists and Pueblo residents collaborated to integrate eco-historical research with Pueblo cultural values to define restoration goals. There are no undisturbed reference sites and no quantitative historical sampling data, so other approaches were used: information from historical research, geomorphological analysis, air photos, and literature review was combined with interviews of elders, Pueblo landscape memories and desires, and sampling previously unrecognized micro-sites found by Pueblo residents. Results of this work are discussed, along with a composite vision of reference conditions, and rationale for selection of a reference time period, applicable to an ecosystem that has included human residents for centuries. Goals now include detailed plans for restoring the degraded river channel itself, and the process is transferable to neighboring communities managing over 50 kilometers of the Rio Grande.

Keywords: riparian restoration, restoration goals, reference conditions, Pueblo Indians, indigenous communities.

Frontiers of dilemma: The environmental Impacts of land reform and their implications on sustainability of forest and woodland resources and rural livelihoods: the case of Mufurudzi Resettlement Scheme (Zimbabwe)

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The survival strategies of resource-poor rural communities in transitional environments hinge on the assets that such communities have. These assets include the human and physical capital, as well as the social networks, financial resources and natural resources that are available to them. In transitional environments where large-scale commercial farming areas have been transformed into resettlement schemes livelihood strategies largely revolve around low input and low cost agricultural production.

These strategies have social and economic implications because they determine levels of both livelihood vulnerability and environmental sustainability. This research focuses on Zimbabwean resettlement areas which in recent years have emerged as fast shifting frontiers along which smallholder agriculture is not only displacing large-scale commercial farming, but also leaving in their wake a trail of even more enduring but subtle "frontiers of dilemma", epitomized by debates regarding alternative decisions and policies that have to be pursued in order to balance resource destruction with conservation. Unfortunately, the balance is presently tipping in favour of the former, with imprints of deforestation everywhere. Under such circumstances livelihood sustainability is under siege since, rural communities, forest and woodland resources are the cornerstone of survival, notwithstanding the role these resources play in supplying daily livelihood requirements such as food, shelter, energy, medicines and other needs, in a harsh macro-economic environment. Evidence emerging from this research suggests that resource destruction and conservation can only be balanced through an integrated approach to rural development.

Keywords: Conservation, environmental sustainability, livelihood sustainability, livelihood vulnerability, macro-economic environment, rresource-poor, transitional environments.

Changes in soil organic matter in the Espinal Agroecosytem of Central Chile with different covers of the Legume Tree *Acacia caven* (Mol)

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The Espinal agroecosystem is conformed by an anthropogenic formation that presents a complex and heterogeneous, savanna-like structure, with herbaceous and woody strata, the latter consisting mainly of *Acacia caven* (Mol). This agroecosytem is in diverse degree of degradation due to man's activities and its sustainability is in risk. The objective of our study was: i) to determine the effect of the canopy cover of *A. caven* on both total soil organic C (SOC) and labile component of the soil organic matter (microbial biomass, respiration and light fraction) and ii) to determine the effect of degradation of ecosystems on the content of both total SOC and labile C. Our results show that the microbial biomass, respiration rate, light fraction and organic carbon of soil are influenced by the presence of the *A. caven* tree, being greater under than outside its canopy. With the degradation of the Espinales the cover of *A. caven* decreases and as a consequence diminishes the microbial biomass at ecosystem level. In this study, microbial biomass size, as biological indicator, was better than respiration of microbial communities in distinguishing between the quality of ecosystems in the soils studied. However, microbial respiration is correlated linearly with light fraction content indicating that the light fraction is an important carbon and energy source for soil microorganisms. The light fraction is a sensitive parameter for determining soil quality, allowing the distinction between the studied ecosystems.

Keywords: Biological indicators, labile organic carbon, light fraction, microbial biomass, microbial respiration, soil organic carbon.

Forest's restoration management plan in Georgia

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The Regional Government of Georgia should lead the development of a strategic plan in cooperation with local governments to improve fire prevention in the interface through fuel management. The plan should: 1) Focus on identification of those areas of the province where communities, infrastructure, and watersheds have the greatest potential to be impacted by large-scale fires. 2) Identify and assign fuel management priorities based on threats to human life, property and resource values. 3) Require a community protection plan in those communities with a high probability and consequence of fire in the interface zone. 4) Be cost shared with local governments. 5) Give priority for funding, fire management planning, fuels mitigation, and protection to these areas. It is not just the responsibility of senior governments to manage these risks. Local governments and individuals must also do their part. Elaborating of Integrated Water Resources Management Plan for Georgia is complicated for this time, because firstly new water legislation should be elaborated, based on the basin approach. Currently we only have prepared the national programme of harmonisation of Georgian legislation (including water legislation) to EU legislation. Restructuring of the forest sector institutions needs to address the following key issues: An appropriate role for the State. We need to set an optimum balance between state and private sector functions and we need to foresee the possibility of roles changing over time as the forest economy and forest governance improve. Decentralisation of power and responsibility. Over-centralisation is a barrier to institutional and

sectoral development. The design of the future institutional structure and allocation of functions needs to provide for de-centralisation at a pace appropriate to the capacity of organisations and people to accept and respond positively to greater power and responsibility. Transparent, participatory decision-making. Macro-level processes of policy development, monitoring and review and micro-level forest management planning processes need to provide for far greater involvement of a wider range of stakeholders, sharing responsibility with the decision makers in government. Restructuring needs to place all of the functions associated with the sustainable management of forests in an effective and efficient institutional framework. Some new functions may need to be adopted, in particular in relation to the ownership of state forests and the management of state forests by new entities. The structure of the framework must be suited to the political, social and economic circumstances of the country. No two countries have identical frameworks; they may have many elements in common but there are nuances that reflect the differences between them. The differences may be due as much or more to political or economic practicality than to real differences of need or purpose. The future institutional structure should be designed around the functions that need to be carried out to support the sustainable management of Georgia's forests and the sustainable development of the sector. Some existing functions may not be appropriate in the future. Functions can be grouped under nine headings.

Keywords: Forest restoration, Georgia, state and private sector, Georgian legislation.

Restoration of *Margaritifera auricularia* (Spengler, 1793) habitat. Implications in its conservation

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Unionids are among the most seriously endangered animals in fresh water worldwide. *Margaritifera auricularia,* nowadays, is one of the most threatened species. Actually the biggest population knowledge is located in the Canal Imperial de Aragón (Spain). One of the main objectives, involved in a general *Margaritifera auricularia* Conservation and Recovery Plan being carried out by the regional government, is the habitat characterization of the species. This will serve to determine the ecological requirements of the naiad in order to implement its captive breeding and design the habitat restoration management needed to ensure its further survival. The Canal Imperial has been sampled taking advantage of the conservation works that need to lower its water level. The results show a clear preference of this specie for the "centre of the river bed" microhabitat, characterized by high values of current velocity and depth. The associated substrate with *M. auricularia* is in most of the cases predominantly gravel and in a smaller percentage sand and slime. In general, it appears in association with another species: *Potomida littoralis*. It has not been demonstrated still but it is believed that there is a strong link between riparian vegetation and the naiad's presence. These results suggest that the main aspects to consider in the *M. auricularia* habitat restoration in order to its reintroduction are: river bed conservation, with special attention at "centre microhabitat"; maintain or/and improve the water quality; substrate management avoiding the deposition of slime; riparian vegetation conservation and trials with other species with similar requests.

Keywords: *Margaritifera auricularia*, restoration, habitat, conservation, Aragón.

Degradation of meadow community and it's natural restoration in Mongolia

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Mongolia has been divided into six broad vegetation zones: desert, desert-steppe, steppe, forest-steppe, taiga and alpine. Our study objective is a grass-herb meadow community distributed in the forest-steppe zone of Mongolia. Study purpose is to study grazing effect on above named community and natural restoration of degraded by heavy grazing stages of this community. Result of monitoring study. With virtually without grazing effect or weak grazing grass-herb meadow community, when irregular and continously used for grazing in all seasons of year, transformed to the herb-wormwood (Artemisia) degraded (heavy grazing stage) community. Heavy pressure leads to the degradation of vegetation: all parameters of the grass stand and floristic richness decline. Compared with weak stages there biomass of fooder, palatable plant species were decreased to 2.5 times and unpalatable plant species as weeds were dominated, biomass of these more increased. It leads to deterioration of pastureland. For natural restoration of herb-wormwood degraded stages of grass-herb meadow community we have isolated it of grazing pressure on 9 years. After cessation, during the this time herb-wormwood degraded community recovered to the herb-grass community, in improved all parameters of grass stand, it's cover percentage and it's duality.

Cessation of grazing pressure is one of methods to renew the state of degraded community, to increase main biomass and improve quality of pastureland.

Keywords: Mongolia, grazing, meadow, natural restoration.

Revegetation in motorway slopes in SW of Andalusia (Spain): testing the effect of tree types of soil materials in some herbaceous native species

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The protective effects of plant biomass in slopes are well known. However, the generalised use of non-native plants in roads increases the risk of plant invasions. In addition, species should be selected depending on the type of substrates. The area object of this study (N-340 Cádiz-Gibraltar motorway) has three types of substrates: bioclastic sandstones, blue marls, and soil cover. The main aim of this study was to evaluate the responses of five native species: *Bituminaria bituminosa*, *Brachypodium phoenicoides*, *Calendula arvensis*, *Malva sylvestris*, and *Plantago coronopus*. Specifically, mixed seeds of these species were sown in a slope with the three types of substrates. Cover and abundance of plants were measured, and similar values were found in soil cover and bioclastic sandstones. These values were significantly higher than those found in blue marls. On the other hand, ten plants per species and substrate were sown in a greenhouse. At the end of three months we weighted aerial and underground biomass. The aerial and underground biomass of *Plantago coronopus* and *Calendula arvensis* were in general more than three times higher than the other species. However, there was an important variation in the different substrates. In conclusion, to assure the success of a revegetation, we should use different seeds mixtures depending on the kind of substrate.

Keywords: reclamation, aerial biomass, underground biomass, soil cover.

Monitoring and reinforcement of the last remnant population of the critically endangered *Cistus heterophyllus* Desf. in Spain

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Cistus heterophyllus Desf. is an Iberian-north African endemic rock rose with only 20 wild individuals left in Spain: a single old individual in Valencia Province and a population of 19 young individuals in Murcia Province which are descendants of nine mature individuals that disappeared after a fire in 1998. We have monitored the wild Murcia population since its origin, assessing growth, flowering and seed production annually. On the other hand, four new clumps were planted in 1999 and 2000 using *C. heterophyllus* saplings grown in the nursery from seeds gathered from the remnant population before the fire. These experimental reinforcement populations are located in the surrounding area in different ecological conditions and have been subjected to the same monitoring as the wild population. Results show that the wild population suffered a dramatic decrease during the first summer but became stable over the following years. Wild plants began to flower during the second year. Population seed production increased threefold between 2002 (10415 seeds) and 2003 (31032 seeds). Growth and seed production data showed significant differences among reinforcement populations, as only two of them displayed similar growth as the wild population and only one showed comparable seed production. We argue soil analysis can help explain these differences.

Keywords: *Cistus heterophyllus*, endangered, plant restoration, reinforcement population, Southeastern Spain.

Direct sowing of shrubs using facilitation by *Stipa tenacissima* tussocks in a semiarid steppe

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A study to evaluate shrubs seedling establishment from seeds using facilitation by *Stipa tenacissima*, a perennial grass dominant in semi-arid steppes from SE Spain is presented. We sowed two late-succesional shrub species (*Quercus coccifera* and *Rhamnus lycioides*), three early-succesional shrub species (*Cistus clusii*, *Helianthemum violaceum* and *Anthyllis terniflora*) as well as *Stipa tenacissima*. We tested two sowing microsites in the grassland: microsites adjacent to *S. tenacissima* tussocks or inter-tussocks mi-

crosites (bareground areas). Soil moisture was significantly higher in tussock than in intertussock microsites during much of the experimental period. Results show a direct facilitative effect of *Stipa* tussocks on germination of most of sowed species. Seedling recruitment was over threefold higher in tussock than in inter-tussock microsites for the late-succesional species. Nevertheless, seed predation and interannual climatic variability may condition survival rates of recruited seedlings. We discuss methods to improve seedling survival. We conclude that direct sowing may be a useful tool for restoration projects of sensitive areas in which minimizing land preparation impact is a priority.

Keywords: Facilitation, plant restoration, seedling establishment, semiarid, *Stipa tenacissima*.

Restoration of lake-shore vegetation from sediment seed bank

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The construction of vertical concrete shore protection as well as intense water level control for water development have deprived most Japanese lakes of their eco-tone vegetation zones embracing high biological diversity. In 2002, a pilot restoration for the lakeshore vegetation was launched in Lake Kasumigaura, the second-largest lake in Japan. By the mid 1990s, the lake has completely lost submerged vegetation, which once covered 7.5 km^2, together with 67% of the area of emergent vegetation and at least 26 aquatic plant species. Aims of the pilot restoration are to ascertain the potential and to develop appropriate techniques for the restoration of lakeshore vegetation at sites where the vegetation had been completely lost. The following hypotheses concerning vegetation restoration were tested in the project: (1) Soil seed banks in lake sediments from the littoral zone[21] can be used to restore species-rich lakeshore vegetation. (2) Species-rich lakeshore vegetation can be restored from donor seed banks within a short period of time if the soil is thinly spread over the ground surface of artificially constructed shores with considerable topographic variation. Lake sediment of ~0.5 m soil depth was dredged from around fishing ports and stored for 2 to 4 months to allow drainage of the water, before spread thinly (~10 cm) on the surface of an artificial littoral zone with micro-topographic variations which had made with sand at the front of the concrete levees. The artificial littoral zones ranging from 5300 to 27 800 m^2 were constructed at 5 locations along the lakeshore. To reduce wave action and to stabilize the shores, several types of protective structure were placed at the lakeward side of each site. Floristic surveys of the restored lakeshores were conducted in June and October 2002 by exploring the entire areas. To analyse the relationship between ground height relative to the water level and the distribution of each species, we established 286 quadrats (each 1 × 1 m, 30–44 quadrats/site) at 2-m intervals on lines set at right angles to the levees at 10-m intervals to cover the whole range in ground height. The species occurring in each quadrat and the ground height at the centre of the quadrat were recorded. We demonstrated that vegetations with a great variety of aquatic and wetland plants, totally accounting 181 species including some that are extinct in the aboveground vegetation, were restoed from the lake sediment.

Keywords: eco-tone, vegetation, lakeshore, seed bank, aquatic plants.

Can artificial sowing of target species speed up succession in disused basalt quarries?

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Steppe-like dry (semi-natural) grasslands are among most valuable and very rare habitats in central Europe. In the study area (the české středohoří Hills, western part of the Czech Republic) they occur in small fragments on southern slopes of vulcanic hills. Because the area is largely affected by quarrying, they often occur in a vicinity to the quarries. The main question was: are species typical of the dry grasslands able to grow in the disused quarries and, if limited by dispersal, can they be sown artificially to speed up succession? Because many of those grasslands were destroyed by quarring, their restoration should be an ultimate goal of reclamation activities. I performed a sowing experiment and followed seedlings recruitment of five species, typical for the dry graslands, in 10 bazalt quarries located in 3 different climatic regions during 4 years. The sowing experiment was established in initial stages of comparable quarry etages, shortly after quarring was stopped. The objectives of this study were i) to evaluate seedlings recruitment in initial successional stages in basalt quarries; ii) to show importance of climatic conditions on surviving seedlings in tree distinct climatic regions; and iii) to demonstrate influence of weather fluctuations among years on seedlings survival. Seedlings of all study species are able to survive in initial successional stages in quarries. All species, except one, showed significant differences in abundance of survived seedlings

among climatic regions. Seedlings recruitment was best in the driest and warmest region. Seedlings of two species did not recruit in the wettest and coldest region. Different weather conditions in the studied years significantly infleunced seedling establishment of two species. Obviously, artificial sowing can be considered in restoration programs as a way how to restore dry grasslands.

Keywords: Recruitment, dispersal, sowing, bazalt quarry, succession, restoration.

The role of integrated water resources management in the restoration of Mediterranean temporary streams in the Costa Brava, Catalonia, NE Spain

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Biological wastewater treatment has been progressively implemented in the Costa Brava (resident population, 150,000 inhabitants; maximum estimated occupation, 1,100,000 inhabitants) since the mid 70's, after the creation of the Consorci de la Costa Brava (CCB, Costa Brava Water Agency). Paralelly, local overdrafted aquifers have been relieved from the pressure imposed by seasonal drinking water needs, because of imported resources and demand reduction through water reuse. Riera de Tossa and Ridaura, both located in the Costa Brava area, are two mediterranean temporary streams that have been ecologically benefited from an improved water resources management based on: i) adequate management of drinking water sources, combining the use of local aquifers and external resources; ii) groundwater conservation through reuse; iii) reduction of discharge of pollutants through an improved operation of WWTPs; and iv) active reuse, after advanced wastewater treatment, for environmental enhancement. Multidisciplinary team work and monitoring of physical, chemical and biological parameters has allowed to gather a set of data to illustrate how integrated resources management has improved the ecological status of these two streams.

Keywords: integrated water resources management, mediterranean streams, temporary ecosystems.

Effects of herbivory of goat cattle in three plant associations in the Tehuacán Valley, Puebla. A study diagnose for restoration

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In this work, we evaluated the direct and indirect effects of goats grazing on three plant associations in the Tehuacán Valley: Tetechera of *Neobuxbaumia mezcalaensis*, Izotal of *Yuca periculosa* and Candelillar of *Euphorbia antisiphilitica*. Based in the characterization and analysis of the management and the diet of the goats, we establish a natural experiment with different intensity of foraging, in order to determinate if there were relation between this factor and the diversity and facilitation on three plants associations. We expected to found a that the diversity of the associations chosen with similar environmental conditions changed in zones with different intensity of foraging and the goat mainly selected shrubs of the family of the Fabaceae. The results indicated that goats preferred the plants of the following families Fabaceae, Turneraceae and Verbenaceae. Data of experiments of nurse indicate that species of these families can be considered like key species that *Lippia graveolens*. The frequency of visits to the Tetechera was the highest compared with other plants associations. In this association the diversity diminishes and indirectly the cacti regeneration associated to nurse plants is also affected compared with sites with less intensity of foraging. Whereas in the Candelillar and Izotal the pressure of herbivory by goats was minor that in the previous case. In these associations the plant diversity was greater in the sites of high intensity of foraging. The present information allows to a better understanding of the system, in order to develop better strategies of suitable develop, conservation and restauration.

Keywords: goats, plants association, Tehuacán Valley (Puebla, Mexico).

Rehabilitation of degraded espinales in the Mediterranean Zone of Chile using annual legumes and multipurpose trees

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The vegetation of Central Chile has been profoundly transformed from highly diversify woodland and shrubland communities to an anthropogenic savannas dominated by the legume tree, *Acacia caven* ("espino") with an herbaceous strata. Unfortunately, a large fraction (69%) of this agro-ecosystem, called "Espinal", is in advanced state of degradation with less than 25% tree cover. Several revegetation treatments of the degraded Espinal (control) were evaluated: a) natural pasture and phosphorus (P) fertilization, b) mixture 1 of self-seeding annual legumes (*Trifolium subterraneum*, *Medicago polymorpha* and *Trifolium micheliamun*) plus P, c) mixture 2 of self-seeding annual legumes (*Ornithopus compressus*, *Ornithopus sativus* and *Biserrula pelecinus*) plus P, d) planting of a fodder legume tree (*Chamaecytisus proliferus* subsp. *palmensis*) with mixture 1, and e) planting a multipurpose tree Cork oak (*Quercus suber*) with mixture 1. After two years, P fertilization did not increase dry matter production (DM) of the natural pastures. The specific contribution of annual legumes to the pasture ranged 71-92% and 40-57%, in the first and second year, respectively. Cumulative DM (2003 and 2004) ranged 4.4–5.4 ton ha^{-1} in mixtures, with no differences among treatments, compared to 2.7 ton ha^{-1} of the natural pasture. In 2003, seed yield of annual legumes was on average 400 kg ha^{-1} in mixture 1 (with or without trees) and 700 kg ha^{-1} in mixture 2, which ensure good re-seeding in the following years. Survival rates of *C. proliferus* and *Q. suber* after two years was greater than 90%, and plant height reached 105 and 69 cm, respectively.

Keywords: annual legumes, dry matter, tree planting, Tagasaste, Cork oak.

Networking of local Marine Protected Area (MPA) managers in Lingayen Gulf: A potent tool in sustaining management

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Networking of local Marine Protected Area (MPA) managers within a defined geographical location of shared management units promotes cost-effectivity, consolidates management efforts and helps ensure management sustainability. Series of community consultations and focus group discussions complemented with reviews of various documents (e.g. local ordinances and management plans) were conducted in five (5) adjoining municipalities in Lingayen Gulf (northwestern Philippines). Three management schemes were noted: (1) localized management at the village-level with a municipal-wide federation of local MPA managers; (2) village-level, but without a federation; and (3) municipal-level, where more than one village is managing an MPA. At the village-level, management is localized and does not entail critical participation of other resource users within the same village. Such constraint was addressed through federation building wherein advocacies were up-scaled resulting to mobilization of communities to participate in MPA management. On the other hand, municipal-level management actively involves local government officials and resource users in relatively more villages. Issues and problems in all management schemes were similar but extend beyond the management unit of each MPA and municipality/city. Resolving management issues at individual MPA level have difficulty in addressing trans-MPA and trans-municipal conflicts. Thus, integration of management plans through networking of all MPAs in the area could therefore provide an opportunity for inter-municipal/city collaboration that is critical in sustaining MPA management.

Keywords: Marine Protected Areas, MPA networking, inter-municipality collaboration, sustainable management.

Using legumes and mid-successional shrubs for ecological restoration of shrublands and degraded sites in arid zones

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Restoration is playing an increasingly important role as natural habitats become scarcer and chances to restore ecosystems damaged by human activities are more common. Restoration of plant communities in degraded ecosystems is especially hard in Mediterranean semi-arid environments mainly due to the lack of rains and their variability. Many restoration projects carried out in these severe environments using

native late-successional species (mainly *Pinus halepensis* and *Olea europaea* var. *sylvestris*) have failed because of high plant mortality. In the last few years new techniques have been developed to increase the establishment of these species, although the use of other native species would be preferable as they are able to successfully establish even in dry years. The results of field essays carried out with traditional techniques in several semi-arid sites in Almería showed that shrub species such as *Ephedra fragilis* and *Salsola oppositifolia*, or leguminous shrubs like *Coronilla juncea*, *Genista umbellata* and *Retama sphaerocarpa*, showed survival rates ranging 66-85%, while species of *Tetraclinis*, *Ceratonia*, *Pinus*, *Olea* and *Pistacea*, frequently used in regular restoration projects, did not reach 40%. Thus using shrubs and legumes may be advantageous, they not only reduce mortality rate, but also contribute to a proper ecosystem restoration because of their ability to increase soil fertility, eventually facilitating establishment of other species, and constituting a source of propagules due to their capacity to flowering early. Such species should be included in restoration programmes of degrades sites.

Keywords: degraded sites, ecosystem restoration, legumes, arid zones, shrubs.

Indicative role of macrofungi in forest regeneration and development

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Mycological monitoring, after several years of preliminary surveys, started in 2001 parallel in forest reserves of two mountains in Hungary. The long-term purpose was planned to be the control of the impacts of forest management onto the species composition, species richness and functional distribution of macrofungi. As result, richness in dead wood of the forest reserves is very important for the maintenance of fungi as a source of nutrition, and thus significantly increases diversity. Dead wood of different dimensions as well as states of decomposition, namely, serves with variable habitats for lignicole macrofungi. The conditions of forest stands are well characterized by the functional spectra of their macrofungal assemblages, suggesting, that these spectra are good mycological indicators of the state of forests. Some species were identified which are indicators of some characteristics of the forests, such as naturalness, the age of the forest, the amount of dead wood and the completeness of the decomposition cycle. The investigations pointed to the importance of forest reserves, which serve as refuge for rare species and make possible for these species in the course of time to return into managed forests.

Keywords: forest management, macrofungi, functional distribution, indicative role, diversity.

A long-term influence of nursery culture techniques in field performance of kermes oak (*Q. coccifera*) in a Mediterranean semi-arid region

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Nursery culture techniques in forest species have suffered intense changes, i.e. containers and fertilization have evolved from small and rustic plastic bags and low fertilization rates to sophisticated containers and improved fertilization regimes. However, the effect of changes in culture techniques have not been much tested in the field. The main goal of this study was to elucidate, after eight years of plantation in the same experimental field in Alicante (Spain), the biomass allocation patterns in kermes oak previously cultivated in small containers (150 cm^3/cell) with low fertilization rates, or in bigger containers (300 cm^3/cell) with higher fertilization. Seedlings cultivated in large containers had three times more biomass than plants cultivated in small containers, being variation mainly for leaf and shoot biomass. Moreover, large plants had 1.6 times higher shoot: root ratio than small plants. After 8 years, no significant differences were observed between both groups neither for total (aerial and root) biomass, foliar and shoot biomass, nor for shoot: root ratio. Nevertheless, plants from large containers showed a bigger shoot, double fine and structural root biomass and 3 times more length of roots. Thus, in the field, differences in biomass parameters, but not in structural parameters, tended to vanish during growth. Plants from both treatments presented 84,14% of roots in the uppermost 30 cm, and most structural roots in NE orientation. However, large plants showed slightly greater radial soil colonization (46,1 dm^3) and 6 times higher root density. Large plants may, therefore, exhibit a higher water absorption capacity as a consequence of a more intense soil exploration and, even if it was not reflected in plant's biomass increase, they could present a higher capacity to survive under harsh conditions.

Keywords: ecosystems restoration, nursery management techniques, seedling morphology, root colonization.

Evaluating the revegetation of gypsum quarries in the semiarid region of Almeria (SE Spain) in terms of the substrate and added compost

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This study forms part of the restoration policies adopted in 2001 in landfills of "fines" and "steriles" produced during the exploitation of the largest gypsum quarry in Europe "Los Yesares", in Sorbas, Almería (Spain). Part of this quarry is also the gypsum outcrop that constitutes the "Paraje Natural del Karst de Yesos" (a "protected landscape" according to European legislation), which boasts a high density of local endemisms (*Helianthemum alypoides* and *Teucrium turredanum*), some with a distribution restricted to the Iberian SE (*Chaenorrhinum grandiflorum*, *Narcissus tortifolius*, *Coris hispanica* and *Santolina viscosa*), Iberia (*Gypsophila struthium* and *Ononis tridentata*) or Iberian North Africa (*Helianthemum squamatum*). Over the years, mining activities have directly affected gypsophyte shrublands, threatening the preservation of biodiversity. One of the restoration measures underway in both landfills involves trying to accelerate the ecological succession process proper to the natural plant communities of the quarry's surroundings. The present study focuses on two successional series, in which a layer of soil from the current exploitation front of the quarry was added to the landfills along with organic matter, in the form of an MSW compost. Over a 3-year period, we have been monitoring the growth of plants in fixed plots amended with different doses of compost. Using geostatistical tools, changes produced in the overall plant cover (woody and herbaceous species) and the cover achieved by *G.struthium* have been assessed in both landfills.

Keywords: gypsum soils, endemic plants, organic amendments, geostatistics.

The effect of the morphotype constraints and the provenance of *Quercus coccifera* L. acorns on the germination

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The aim of this paper is to determine the effect of the morphotype constraints and the provenance of *Quercus coccifera* L. acorns on the germination. The two areas of provenance that have been analysed in this study differ in their environmental conditions: a semiarid area with an average precipitation of 271 mm. and a subhumid area with an average precipitation of 833 mm. The morphotypes analysed in this research have been selected according to the size of the leaves of individuals of populations growing in a semiarid area, for this morphological trait may well be an adaptive response to a particular environment. Our hypothesis is that the adaptive response of plants to different environments can result in significantly different morphological and physiological behaviours, which will in turn have an effect on the germination process. The results suggest that the germination of seeds origined the different morphotypes vary from one population to another, whereas the effect of the provenance factor depends on the morphotype. Altogether, the evidence of this study can help identify the populations or individuals whose seeds are more likely to germinate successfully, this being an essential preliminary step to the restoration of degraded areas.

Keywords: Provenance, morphotype constraints, germination, *Quercus coccifera* L.

Evaluation of woody regeneration under tree mixed plantations in a Mexican Cloud Forest

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The establishment of plantations has been proposed as a tool for forest restoration because the overstory of plantations influences the recruitment of new species. The study evaluated the spontaneous woody vegetation growing under three mixed plantations established 5.5 year ago in two old-field with ten years -old abandoned: site 1 with remnants trees, and site 2 covered by *Pteridium aquilinum* and *Rubus pringlei* as dominant herbs; and a two weeks of abandoned pasture (site 3). The objectives were to calculate and compare the abundances of spontaneous tree species (> 5cm, dap) growing there and compare tree richness with previous secondary vegetation, using the Importance Value Index (IVI) which is sums of relative abundance measured as density, frequency and dominance. Site 1 and site 2 had more than 600 trees/ha, and 12 and 6 tree species respectively, where ten and two species respectively belongs to cloud forest climax. Meanwhile the recently abandoned pasture (site 3) had 58.3 trees/ha, all were five secondary woody species. Before planting, 380 trees/ha were counted in site 1 where mostly were seedlings of

10 species of old remnant trees. The IVI was higher for the spontaneous woody plants in site 2 (*Alnus acuminata* and *Clethra mexicana* had 70%) and site 1 (*Quercus xalapensis* and *Lippia myriocephala* had 67%), than site 3, where the planted *Liquidambar styraciflua* had 38.6% and spontaneous *Lippia myryocephala* had 21.7%. In conclusion, the plantations promoted the natural trees regeneration, and number and quality of woody species depended on the presence of tree source seeds.

Keywords: Cloud Forest, native tree plantation, spontaneous tree regeneration.

Effect of planted tree species on formation of herbaceous vegetation on reclaimed oil shale opencast mines in Estonia

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Our goal of was to study whether the formation of the herbaceous layer was dependent on tree species planted on the spoil of an oil shale opencast mine reclaimed in the 1960s in Estonia. Species richness and biomass of herbaceous plant species was surveyed in 0.2 m^2 quadrates in four different stand types. The stand types were: monospecific plantations of (1) *Alnus glutinosa* (European black alder), (2) *Betula pendula* (silver birch), (3) *Pinus sylvestris* (Scots pine), and (4) mixed plantations dominated by *Larix sibirica* (Siberian larch) and *L. decidua* (European larch). Variation in species richness and biomass was higher within a stand type than among stand types. However, stand type affected significantly the response of herbaceous layer to the stand and soil attributes. According to the results of detrended correspondence analysis, the herbaceous layer of alder stands had the most distinctive species composition. In terms of plant strategy type, alder stands tended to promote the growth of competitors, whereas stress-tolerant species were the most abundant in the herb layers of other stand types. Pine stands differed from the others in having the lowest abundance of competitors. We can conclude that the development of vegetation in reclaimed opencast mines may be constrained to one strict direction determined by the planted tree species. The herbaceous layer may remain sparse in coniferous stands, whereas broadleaved trees may enhance its biomass. Broadleaved tree species may favor competitors, while some conifers may create suitable conditions for stress-tolerant species.

Keywords: Herbaceous vegetation, plantations, oil shale mines, restoration.

Implications of the interactions between shrubby legumes and rhizobia in land restoration

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Re-establishment of vegetation in nitrogen-deficient soils can be hazardous, especially when climatic conditions are characterized by extreme temperatures and long summer droughts. Due to their wide environmental tolerances, including poor soils, leguminous plant species can trigger plant community recovery by facilitating the establishment of less tolerant species. For successful restoration of native vegetation on poor and disturbed soils it is essential to understand the nitrogen-fixing relationships between plant host species and their bacterial symbionts. It is also paramount to know the growth responses of legumes in response to the available soil nutrients. The aim of our study was to evaluate the effect of inoculation with native Australian and Spanish rhizobial strains on the growth of six Australian and six Spanish shrubby legumes in natural soils from central-western Spain. The Australian species are candidates for use in land rehabilitation in Spain. We also studied the growth of the same species treated at five levels of fertilization. A comparison of inoculated, non-inoculated and fertilized seedlings was performed. Plants were grown in a glasshouse for six months. Host species grew larger in the presence of rhizobial inoculants and this growth was in some cases comparable with the effect of fertilization. Significant differences in plant performance were detected between rhizobial strains obtained from different host species. In many cases, strains that were highly effective at promoting growth of one host legume species were ineffective on other species. These findings indicate that choosing appropriate rhizobial strains for inoculation prior to revegetation programs is critical and should be made on a species-by-species basis.

Keywords: Australian and Spanish shrubby legumes, Mediterranean ecosystems, biological nitrogen fixation, fertilization.

Methodological design of restoration In The Forest Reserve "*Carpatos*"

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The Forest Reservation "Cárpatos" is part of one ecologic area affected by cultural practices. At the moment, 185 hectares of the total 558 are covered with *Pennisetum clandestinum* and *Olcus lanatus* grasses, which slow the natural regeneration and hinder the advance process succession and the stabilization of the ecosystem. The methods are synchronous models in 8 lots of land (100 m^2) in different states of succession, taking the climatic, environmental, and soil data, and the floristic characterization of the mature forest. The experimental design consists of blocks at random with the arrangement factorial 3^3 with the treatments of fire, cutting and observation of the bank of seeds, as well as the use of installation hangers and seed traps. The results indicate the presence of beginning & middle succession process species, opposing conditions that mark the current stagnation of the restoration, such as the decrease of the CIC & potassium level in the soil, which are in high levels in the forest climax. Likewise, outstanding communities are identified to be present and determined particulars as a vector of succession of the association Ocoteo callophyllae- Weinmannietum pinnatae, with the similarity of species to patches (2 and 3). Other results are in progress to obtain the process of analysis of variables for experimental design. The conclusion consists of the succession tendency of the presence of the communities under the mature forest and the topographical conditions. The use of fire is the best treatment to reactivate the dynamic succession in soils degraded by atrophic practice, since it can break the stay state of the seeds. The bank of seeds of the reservation remains in good condition and it can be a good starting point to reactivate the dynamic succession.

Keywords: Forest, restoration, succession, biodiversity, seeds bank.

Soil seed bank viability from an evergreen oak stand in Navarra (Spain)

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The vegetation and its restoration were studied in an evergreen oak stand in Nazar, northwestern of Navarra (Spain), which got fired in 1994. Soil seed bank is essential to study and evaluate natural restoration of the vegetation and plant species conservation. Moreover, a soil seed bank analysis is necessary to give the whole description of the vegetation, so its composition, density and viability are being studied in Nazar since November 2002. Soil samples are taken from three different areas (control, fired and fired and cleared area) using a corex cylinder. The 5 upper centimetres of the soil are extracted and two depths are distinguished in each sample: the top 2 cm and the bottom 3 cm. The methods of seed bank analysis are: the physical separation of seeds with a stereo microscope or direct method and the seedling emergence or indirect method. The seeds viability is tested by the seedling emergence in a greenhouse (indirect method), by colorimetric techniques using a solution of 2,3,5-triphenyltetrazolium chloride (0,1%) and by direct observation of the endosperm after cutting open the testa. The current research aims to analyse and compare the viability of the seed bank using the indirect method and the colorimetric and observation techniques.

Keywords: endosperm, 2,3,5-triphenyltetrazolium chloride, greenhouse, embryo, testa.

Restrictions in the restoration of the pluvial forest of Chile. A case of study: Forest of Chiloe's Island (42º - 44º South)

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The Chilean pluvial forest (valdivian forest) is extent from 40º to 44º south latitude, being one of the larger biodiversity ecosystems in South America, with development of great trees such as Nothofagus, Mirtáceas, and conifers, but also rich in bushes, epiphytes, lianas, convolvulus, tree ferns, lichens and big herbals. In Chiloe lives one of the world's longeval conifer: *Fitzroya cupressoides* (Mol) Jhonst. This dense forest was burnt many times since the beginning of the XX Century, in order to open up areas for habitats, lands for animals and agriculture. In our days, the forest is still under exploitation as a wood and energy resource. The domestic energy consumption still depends on forest exploitation. For other hand, looking for high quality wood such as *Pilegrodendron uvifera* conifer (D, Don) Florin in the south of the island, incentives the burning of the forest. We analysed the possibility of natural restoration of these forests in areas where the native vegetation, in regards to other latitudes, has not evolved with the fire and for this reason, they do not have the defense's mechanism against that. In our days, the restoration

of these fragmented forest ecosystems, presents many difficulties such as: the cutting of the best tress for wood and fire-wood, impacts for the open up of roads, substitutions of the native trees for exotics populations in degraded areas, and burning for new prairies. It is not noticed a regeneration with native forest because they have to contend with bushes of fast growing and also for the invasion of exotic species which make the restoration of the conifer a very difficult task.

Keywords: Ombrophilous forest, burnt, fragmentation, biodiversity, Nothofagus.

Heavy metal removal from "Chinampa" System soils by *Cynodon dactylon*, *Suaeda torreyana* and *Beta vulgaris var. cycla* under greenhouse conditions

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"Chinampa" system (artificial islets built on shallow lake), is an highly productive pre-hispanic agricultural method that yet nowadays is commonly employed at Xochimilco zone, in the South of México City. Nevertheless, actually there are soil pollution by heavy metals and salinity in "chinampas" due to low water quality used for channel re-filling and for culture irrigation purposes. For this, the objective of this work was to evaluate the removal capacity of nickel, zinc, lead, cadmium and copper from soil samples, by the plant species: *Cynodon dactylon, Suaeda torreyana* and *Beta vulgaris* var. cycla, in greenhouse conditions. The experimental design was made for comparing two sampled populations of data: a) soil parameters before and after plant culture, b) plant development on pots with polluted soil and on pots with clean substrate and c) heavy metals concentration in roots, stems and foliage of plants grown on polluted soil *versus* plants cultured on clean sustrate. The results show that polluted soil is highly saline (electric conductivity is 12.72 dS/m), with pH of 8.14, 16.6% of organic matter and loamy sand texture; the soil heavy metals concentrations means were (in mg/kg): Ni: 135, Zn: 397, Pb: 323, Cd: 18 and Cu: 193. After plant culture, the heavy metals concentration in soil of *C. dactylon* were: Ni: 133, Zn: 129, Pb: 343, Cd: 17 and Cu: 19; for *S. torreyana* the soil results were: Ni: 147, Zm: 135, Pb: 196, Cd 17 and Cu: 21; finally, for *B. vulgaris* var. cycla soil concentration were Ni: 114, Zn: 145, Pb: 341, Cd: 17 and Cu: 18. It was concluded that phytoremediation has an higly potential for heavy metal removal in polluted soils of "chinampas".

Keywords: Phytoremediation, heavy metals, Xochimilco, soil salinity.

Extinction risk of threatened wood-living species in forest landscapes in relation with different histories and restoration strategies

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Dead wood is a critical resource for biodiversity in boreal forests. We analysed the persistence of hypothetical species inhabiting dead wood with characteristics that may be similar to species on national red-lists, by combining a metapopulation model with models of dead wood dynamics of Norway spruce in central Sweden. Dead wood generated by altered management over the entire landscape was found to be less efficient in reducing extinction risks in comparison to the same amount of dead wood generated by protecting reserves. Because generation of dead wood by altered management is often less expensive than generation by setting aside reserves, it is difficult to determine which conservation measure that is most cost-efficient. The species' colonisation ability was a critical factor for the efficiency of altered forest management, but empirical data are scarce. In a landscape that is used for forestry for the first time, it was better to preserve a few large reserves than many small. However, in a managed, highly fragmented forest landscape, it was better to set aside many small reserves, because it was possible to select small plots with high habitat quality, while the latter originally contained habitats both of high and low quality, and the rate of habitat quality increase was low. A strategy for biodiversity conservation in a managed forest landscape should include information about the history of the landscape, the current amount and spatial distribution of forest habitats, and the potential for rapid restoration of forest habitats, both on managed and unmanaged forest land.

Keywords: population viability analysis, restoration, saproxylic, SLOSS.

Cost efficiency of measures to increase coarse woody debris to preserve biodiversity

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Changing silvicultural methods to improve habitat quality for forest organisms has become one of the main means to preserve forest biodiversity in Fennoscandia. In boreal forests, coarse woody debris (CWD) is an important substrate for red-listed species. Several modelling and field studies aim at evalutaing the efficiency of measures to improve habitat availability for species dependent on CWD. Here we present a modelling study in which we analysed cost efficiency of five management measures taken in Swedish forestry, which aim at increasing CWD in managed forests: retention of living trees at harvest, artificial creation of high stumps, manual scarification at clearcuts to avoid destruction of CWD, prolongation of the rotation period, and retention of naturally dying trees. For Norway spruce (*Picea abies*) stands in different parts of Sweden, we calculated the present value and predicted the amount of CWD that will be present if the same management method is used over a long time. To retain reasonable amounts of naturally dying trees was always inexpensive, and in central and northern Sweden it was more economical to retain them than to harvest them. Creation of high stumps was a cost efficient method to increase the amount of CWD. Prolonging the rotation period was the most expensive way to increase CWD. We conclude that adopting several different measures to increase CWD in managed forests, as prescribed by certification standards today, is a good concept, but to be cost efficient the focus should be on different measures in different parts of Sweden.

Keywords: Dead wood, forestry, FSC, Green tree retention.

Restoration and management of mangrove forests through people's participation: experiences from India

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Mangrove forests are one of the most productive and biodiverse wetlands on earth. They are multiple use ecosystems that provide protective, productive and economic benefits to coastal communities in the form of wood products, non-wood products and aquatic products. Environmentally, mangrove forests act as a barrier against cyclones and prevent entry of saline water during storm surges, act as a buffer against floods and prevent coastal erosion, provide nursery grounds for a number of commercially important fish, enhance the fishery production of nearby coastal waters and provide habitats for wildlife. Today, coastal bio-diversity including the mangrove forests are under severe threat due to urban expansion, industrialization, pollution, human habitats, tourism and other associated human activities resulting into decline of marine life, degradation of clean water supplies, salinization of coastal soils, erosion, and land subsidence, and the release of carbon dioxide into the atmosphere. Another reason for such large-scale destruction is that until recently, the mangrove management plans gave importance only to the forest component of the mangrove wetlands and very limited or no attention was paid to the hydrological processes which are responsible for the stability of the mangrove. At the same time, insufficient attention is given to the inter-relationship between the health of the mangrove wetlands and the land and water use practices that are followed in the regions adjacent to mangroves. In addition, most of the mangrove management plans have failed to involve the local community as participants. In order to find viable, long-term, equitable solutions to mangrove deforestation, it is necessary to support and initiate small-scale mangrove restoration projects and promote hydrological rehabilitation of mangroves through active participation of the local community in the restoration and management process. Besides this, public awareness about the importance of mangrove forests should be promoted among the various stakeholders including local youths and grass root NGOs, who later must take the responsibility to conserve and sustainably manage their coastal forest areas. There is a need to support innovations in appropriate technologies and sustainable livelihood alternatives that help coastal communities to supplement their incomes in time of crises. Thus, we need to implement a pro-active five-pronged approach comprising of education, advocacy, collaboration, conservation and rehabilitation and sustainable community based development, for effective restoration and long term of preservation of mangroves.

Keywords: mangrove forest, restoration, biodiversity.

The effect of fertilizers and hand planting on restoration of coastal zones, Caspian Area-Iran

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Some years ago Plantation of Pinus pinea in the coastal zone of Caspian Sea(Jafroud) as an Exotic species afforestation have been done. Now the most important matter is how to survive these hand plantations through treatments to restore vegetation cover of the coast. Early experiment of soil characteristics showed that Pinus pinea face with high lacking of "N", "P" and "K" elements. So a factorial fertilizer plan in the form of randomized complete design with four replications was carried out in this region throughout fertilizer sprying.Factor 1 was consisted of 3 levels of area fert. (a1=112, a2=224 and a3=336 kgN/ha), factors 2 was consisted of 3 levels of super phosphate fert. (b1=56, b2= 112 and b3=168 kgP2O5/ha) and factor 3 was consisted of 3 levels of potassium chloral fert. (c1= 22.8, c2=45.6 and c3=68.2 kgK2O/ha). Fertilizing had been carried out in two times, one in August 1999 and the other in March 2000.The purpose was identifying of the effects of fertilizers on height, diameter, tree needles and also on the concentration of "N", "P" and "K" elements on those trees. So we have measured and derived the effects on these parameters. At last results showed that the mixture of "N.P.K" fertilizers on the growth of height and tree needles has an agreeable effect on them. The highest growth needles and height was in a3b2c2 treatment. There was a high and significant correlation between growth of tree needles and growth of tree height. Also the main element limiting growth was N.

Keywords: Soil characteristics, Pinus pinea, limiting-growth, macro element, critical nutrient level, factorial fertilizer plan.

From fruit to frond in four short years–plant rescue & site rehabilitation, Coega, Eastern Cape, South Africa

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On one hand, the inception of a massive, and controversial, industrial development project based around the construction of a deep-water port and surrounding industrial development zone (IDZ) in 2001 promised a much-needed economic boost into one of the poorest provinces of South Africa. On the other hand, the development site, some twelve-and-a-half thousand hectares in extent (31,000 acres), threatens a unique natural environment that has been the cause of much contention by environmental groups across the globe. The SA government acknowledges these concerns but claims that the social and economic returns will outweigh the environmental loss. Construction of infrastructures is now well under way and these adhere to far reaching environmental guidelines recommended by national conservation bodies and scientists. In the light of the need for environmental agencies to implement these guidelines in a holistic and sensitive manner, the company, ECCLES, was registered in 2001. ECCLES focuses on plant identification, translocation of IUCN Red Data species, rare species, local endemics, and; the rehabilitation of disturbed and degraded areas within this threatened environment with the aim of long-term conservation and integrity of the system, coupled with socio-economic consciousness in a marginalized community.

Keywords: site rehabilitation, South Africa, industrial development, socio-economic, conservation.

Restoration potential of spontaneous vegetation succession in gravel-sand pits: a landscape context

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A spatio-temporal variation of vegetation during spontaneous vegetation succession was studied in 36 abandoned gravel-sand pits in the Czech Republic. The following habitat types were distinguished in the pits: dry, wet and shallow water. They ranged in the age of 1 to 75 yr since abandonment. In particular sites, 224 phytosociological relévés were recorded and surrounding vegetation was characterized. Participation of target species typical of grassland in relatively dry and warm regions, of woodland in relatively cold and wet regions and wetlands significantly depended on the occurrence of the respective communi-

ties in the vicinity of 100 m. Abandoned gravel-sand pits might provide refugia for some rare plant species, especially those typical of nutrient poor substrates and wetlands. Landscape type (forest, agrarian, urban) significantly influenced the course of succession. Intensive agrarian or urban land-use of the landscape up to 1 km around a mining site can led to a greater occurence of ruderal and invasive species in abandoned pits. It can be concluded that semi-natural vegetation can be successfully restored by processes of spontaneous succession. Spontaneous succession reaches, in app. 25 yr, a desirable stage especially if semi-natural habitats still exist in the vicinity of a pit. Nevertheless, expansion of invasive species must be taken into consideration if they occur in the surrouding landscape.

Keywords: gravel-sand pits, land-use, restoration, spontaneous sucession, vegetation.

Restoration technique assessment and investigation: a multi-experiment investigation of *Phalaris arundinacea* L. (reed canary grass) control in wet meadows

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Even cursory post-restoration assessments are rare, leaving little opportunity to evaluate or improve methods from case studies. Here, a coordinated multi-experiment approach investigates effectiveness of restoration practices and suggests avenues for increased success. Effective control is needed for *Phalaris arundinacea*, a rhizomatous perennial grass that preempts native vegetation in northern US wet meadow restorations. Current methods involve spring burning and glyphosate herbicide application, but do not consistently result in *Phalaris* removal and native establishment. A multi-year, multi-site field experiment was the basis for investigating perceived failure of burning and herbicide to control *Phalaris* and promote natives. This experiment demonstrated that 1) late season herbicide applications were more effective, 2) burning did not reduce *Phalaris* or increase herbicide efficacy, and 3) *Phalaris* recolonization limited native establishment. Three follow-up experiments correspond with these results: 1) tissue analysis determined seasonal carbohydrate movement explains herbicide efficacy timing, 2) seed bank assays showed that burning reduced *Phalaris* seedbank, and 3) mesocosm studies revealed that minimal *Phalaris* seed densities limited native establishment, even when native seed density was high. Together, the field experiment and follow-up studies demonstrate that even with effective use of burning and herbicide, additional management (multiple seasons of site preparation control and post-restoration aftercare control) will be necessary to limit *Phalaris* reinvasion sufficiently to establish natives. Determining the mechanism behind failure of restoration techniques is complex enough that multi-experiment investigations are required. Such coordinated research is further justified by the increase in overall restoration efficiency gained from improving techniques based on new understanding.

Keywords: controlled burning, glyphosate, invasive species control, restoration efficiency.

Cultivated nopaleras (*Opuntia* spp.) as a mechanism for the recovery of ecological structure in the "Llanuras de Ojuelos," México

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Natural nopaleras (complex communities dominated by flat-stemmed *Opuntia* cacti) were historically one of the most notorious habitat features of the Llanuras de Ojuelos, central Mexico. During the last several decades large areas of them have been reduced or fragmented through their conversion to dry-land agriculture, their use as rangeland, and through human settlement, causing negative impacts on the native flora and fauna that used them. Re-establishment of natural nopaleras for conservation purposes does not seem viable. Conversely, over the last two decades there has been a widespread establishment of fruit-oriented cultivated nopaleras. These perennial agroecosystems of domesticated varieties of native *Opuntia* spp. are subject to only sporadic agricultural practices. Cultivated nopaleras provide habitat for several of the species that use natural ones. Of 8 rodent species that we have found in natural nopaleras, five occur in cultivated ones; the other depend on rocky soils that are typical of the remaining natural nopaleras but not of cultivated ones. We have not compared yet the bird and reptile communities of both types of nopalera, but our preliminary observations indicate that, at least, many of the species of both taxa that occur in natural nopaleras occur also in cultivated ones. Much remains to be learned on the ecology of both natural and cultivated nopaleras to assess how much of the loss and degradation of the

prior can be compensated by the latter. Nevertheless, our observations evidence that cultivated nopaleras can play an important role in biological conservation of the region.

Keywords: conservation, nopaleras, México, agroecosystems.

Habilitation of lagoons formed by sand and gravel mining activities in river meadows as natural reserves: The case of the river Jarama (Madrid, Spain)

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The main objective of this study was to determine the key parameters controlling the naturalization process of artificial lagoons formed by sand and gravel mining activities in river meadows. Six restored and three un-restored lagoons and lagoon complexes in the Jarama river valley (Madrid, Spain) were studied. We analysed their evolution since mining was terminated. For this purpose, development of helophytic and riparian vegetation as indicators of the naturalization process in wetlands was determined by aerial photography digital processing (with the use of Idrisi32 software). We also gathered qualitative field information on some important parameters for lagoon evolution relating to morphometry, substratum, land uses and vegetation of the surrounding areas, human impact, etc. The results obtained showed that the key factors in naturalization processes of lagoons were shore slope, type of substratum and water level variation. Colonisation by vegetation therefore requires a gentle shore slope, a stable water level and a suitable substratum (granulometry, organic matter, permeability, etc.). In most of the "restored" lagoons the restoration methods carried out had no significant effects on naturalization due to the fact that they did not affect these key parameters. On the contrary, both in the un-restored lagoons, but in favourable environmental conditions, and in those in which the key parameters were corrected, a high level of naturalization was reached in just one decade.

Keywords: Gravel-pit lake, sand and gravel mining, river meadow, Jarama river, Madrid.

Restoration of wetlands invaded by exotic crayfish

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For some decades, exotic species of freshwater crayfish were deliberately introduced in freshwater environments in Europe. The effect of these introductions was not only restricted to the displacement of the autochtonous species but also related to vegetation destruction and strong changes in the whole food-web of the aquatic ecosystems. Restoration of wetlands in which exotic crayfishes have depleted their aquatic vegetation is extremely difficult due to their biological adaptations and the difficulty for reducing the turbid conditions created after plant destruction. An analysis of methods used for crayfish control and clear water phase restoration in shallow lakes are reviewed in the present work. The potential control of crayfish by natural enemies like eels (*Anguilla anguilla*) is analysed after discussing data form Menorca (Balearic Islands). Non-overlapped distribution of eels and red crayfish (*Procambarus clarkii*) in the studied wetlands and the evidences of crayfish predation by eels supports this predator as a reasonable method for exotic crayfish control in Mediterranean wetlands.

Keywords: wetlands restoration, exotic crayfish, biological control, eels.

Differential effect of commercial AMF inocula and native AMF inocula on the growth of *Ammophila arenaria* (L.) Link

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Ammophila arenaria (L.) Link is a perennial, rhizomatous grass that naturally occurs in coastal foredunes of Europe and North Africa. This is the dominant species at the seaward slope and top of foredunes where sand accretion is intense. It is one of the most important species for dune stabilisation and land reclamation projects worldwide. Arbuscular mycorrhizal fungi (AMF) also play an important role in sand dune stabilisation. They enhance plant growth by improving nutrient uptake and sand aggregation and some studies have shown a positive correlation between the density of *Ammophila* plants and the density of AMF spores in soil. Available commercial AMF inoculants are commonly used for agriculture and management

projects. However, several studies have shown that the effect of AMF depends on the identity of both the fungi and plant involved in the mutualism. We design an experiment to compare the effect of a commercial inocula vs. an inocula prepared using soil from the rhizosphere of *A. arenaria* on the growth of this plant species. Plant biomass was measured after 15 weeks of growth under controlled conditions. Significant differences were found between all treatments. Plant biomass was higher in plants colonised by native AMF and lower in plants colonised by the commercial *G. mosseae*. These results highlight the differences in terms of plant benefit between different isolates of AMF. Since the effect of AMF can range from mutualism to parasitism, it is essential a careful evaluation of the inocula to be used for revegetation strategies.

Keywords: sand, dune, *ammophila arenaria* (L.) Link.

Restoration of a species-rich ecosystem from the semi-arid zone of Western Australia following sand extraction

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The south-west of Western Australia is one of the mega diverse regions of the world. The state is also resource rich, producing over one third of the Australian GDP. The ability to restore sites following mining or extraction in these semi-arid lands is of utmost practical importance, but presents major problems in terms of the areas involved, paucity of knowledge on the restoration ecology of native plants and the strong seasonal aridity associated with a Mediterranean-type ecosystem. Further, while the focus of previous mine reclamations elsewhere has been on the restoration of biological components, the soil and hydrologic components generally have been neglected. Studies undertaken by the restoration research group at Kings Park and Botanic Garden, Perth, Western Australia, have enabled research of a wide spectrum of new and innovative methods for tackling post-mining restoration of bio-diverse ecosystems. By analysing soil seed-banks for optimisation of soil-borne seed recoveries, understanding ecological processes influencing plant establishment, and using innovative restoration methods, a highly successful species replacement and rehabilitation program has been established for some ecosystems. Coupled with the use of smoke-mediated germination, which in some systems produces a 42-fold increase in total germinants and a 3-fold increase in number of species, near total species replacement is a very real possibility for some systems. This presentation will review current restoration practises and data on the soil seed bank, soil handling, soil and plant pre-treatments and restoration research being utilised to restore semi-arid vegetation after sand extraction.

Keywords: post-sand extraction, restoration, soil seedbanks, smoke germination, soil pre-treatments, plant pre-treatments.

Tree regeneration in artificial canopy gaps in a protected forest in Finland

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In Finland, many protected forest areas have a long history of utilization, and consequently, they lack several naturally occurring stand characteristics. By creating small canopy gaps, that mimic small-scale disturbances typical for natural boreal forests, it is possible to diversify forest structure and tree species composition and to produce more dead wood while still maintaining the typical microclimatic conditions. The aims of this study are to examine the effects of artificial gap formation on post-disturbance tree regeneration and development. In particular, the effects of size and composition of a gap is experimentally examined. A total of 60 small canopy gaps have been done in young pine (*Pinus sylvestris* L.) -dominated forest in eastern Finland in spring 2003. The diameter of the gap varies from 0.5 to 2 times of the height of the trees in the surrounding forest. The number of girdled trees in the gaps varies from 0 to 100% of all treated trees (cut+girdled) (a measure of the composition). Birches (*Betula pendula* Roth.) were seeded on the gaps, both on the undisturbed soil patches and the disturbed, scarified soil patches. The short-term results show that (1) artificial regeneration of birch succeed poorly, even on the disturbed soil patches, (2) natural regeneration of pine has been plentiful on the disturbed soil, and (3) birch did not regenerate on very small-sized gaps. In conclusion, diversifying of young pine-dominated forests by tree species mixture seems to be difficult when small artificial gaps are used.

Keywords: boreal forest, forest protection, forest restoration, gap dynamics, tree regeneration.

Effects of restoration on species richness and floristic composition of a protected coastal shrubland (Canary Islands)

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Secondary succession of vegetation in arid regions is recognized to be very slow. Few studies document recovery of arid ecosystems after severe disturbances which can be altered by the spread of exotic species. The coastal scrub of Tenerife, rich in native and endemic shrubs, has been dramatically disturbed in the last decades by intensification of land use. Local authorities have developed programmes to restore some coastal areas through landscape ameliorations and restitution of substratum. We evaluated the results of a restoration programme in the Montaña Amarilla Natural Monument (South of Tenerife, Canary Islands). Results of the restoration monitoring including 11 permanent plots showed a steep increase in annual species the first year after restoration, which can be attributed to the addition of soil. Many of these annuals are exotic and some of them reached high cover values. The decline in species richness in the second year after restoration was probably due to climatic fluctuations. The seeding of native perennial species had not the expected success, although ruderal native perennials were more frequent after the restoration. The lack of exotic perennials is mostly due to the eradication programme. Multivariate analysis showed temporal changes in floristic composition but could not yet reveal successional trends. Since propagules of target species are still available in the nearer surroundings, secondary succession towards natural coastal scrub with a substitution of exotic annuals by native and endemic shrubs is expected in the future.

Keywords: Restoration, coastal scrub, richness, exotics, life form, ordination analysis, Canary Islands, secondary succession, arid environment.

Environmental measures on a landscape road in Almonte (Huelva)

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During 2002 the Andalusia Department of Public Works began the upgrading of an existing road located in the surrounding of Doñana National Park crossing one of the main habitats of the Iberian lynx (Lynx pardinus). Attending to some prescriptions coming from different environmental authorities such as Doñana National Park, the Andalusia Environmental Department and ADENA-WWF a complete set of environmental measures were designed by the Public Works Department and implemented during road works in order to reach the following main objectives: Avoid the wildlife barrier effect; reduction of the number of roadkills, (specially for the Iberian Lynx) and environmental-responsible driving behaviour promotion. The road crosses a thick Mediterranean stone pine forest with single cork oak trees accompanied with scrub vegetation and natural prairies giving support to an important wildlife community. Young lynxes born in Doñana use these pine forest for dispersion and it is well known that the traffic of Doñana`s adjacent roads is one of the main causes of their mortality. In this way the following measures were effectively executed: i) drainage works (culverts) redimentioning and fauna underpasses and new bridge at the “Gato” stream used by dispersive lynx as a natural corridor, equipped with lateral high-water paths ii) installation of specific drift fences designed for lynx diversion, extra high and thick in order to guide the animals to the underpasses, iii) escape ramps, iv) deforestation of the roadside stripe, that would dissuaded animals from crossing the road when forced to open field; v) Installation of light-reflexive posts along the road line, vi) construction of underpasses designed for amphibians. Some other measures were also implemented such: i) green colour bitumen along 8 kilometres (green road) that would show the distinctive nature of the road to the drivers, ii) speed traffic limitation, iii) speed control measures such 2 metres long humb section, rumble strips and new round-abouts located in four roadkill high risk sectors identified, and iv) a new rest-area to provide relevant information about the natural values of the site to the visitors.

Keywords: Roadkill, barrier effect, Iberian lynx, public use.

Restoration and environmental compensation measures in the dam of Andévalo (Huelva)

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Presentation relative to the restoration and environmental compensation works in the surroundings of a big dam located in the west of Andalusia (Mountains of Huelva). The Andévalo dam (1830 meters long and 77 meters high) regulated 600 Hm^3 with an overall water surface of 3630 Ha. A number of restoration and environmental compensation actions have been established. Specific emphasis shall be given to the "Quemadillos" island. (360 Ha), which supports a reforestation of eucalyptus in a terraces pattern plantation, showing low indices of flora and fauna diversity and clear problems of soil conservation. The objectives of the works are centred in: i) increasing the biodiversity, ii) protecting the soil and restraining the erosive phenomena and iii) establishing the long term monitoring infrastructures and promoting the public use and information facilities. The most relevant performances are the following: i) eucalyptus plantation eradication and reforestation by using oaks and Mediterranean bush, ii) construction of a fauna permanent overpass over the reservoir to limit the barrier effect, oriented towards the Iberian lynx, iii) creation of pasturelands and natural prairies with local soil improvement, iv) rabbit restock and creation of burrows, v) creation of micro-reservoirs to increase the availability of water for the fauna during the summer, vi) construction of controlled garbage dump for vultures and other necrophagous birds, vii) installation of nests and artificial alights for storks and herons, viii) construction of a half-buried building for monitoring, investigation and public information, complemented with footpaths, signalling and information systems for the visitors. The set of measures has been designed in a synergic form, and lean on the present conditions and aptitude of the zone to undertake the recovery and restoration.

Keywords: Mediterranean bush, restoration, dam, rabbit restock, public use.

Total dissolved and total particulate zinc in the Nozha Hydrodrome, south of Alexandria, Egypt

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The Hydrodrome, covering area of 5.04 km^2 and average depth of 2.11 m, became polluted in recent years from the feeding contaminated Nile water. Surface water samples were collected monthly from this lake for studying seasonal distribution of total dissolved zinc (TDZn), total suspended matter (TSM) and total particulate zinc (TPZn). The high amounts of TSM affected the distribution of TDZn. The behavior of Zn was generally governed with pH variations, influencing adsorption/desorption processes. The relative increase in TDZn in the lake compared with earlier data illustrates the effects of heavy metal pollution in recent years. The maximum average TDZn value at the location of breeding ducks coincided possibly with the erosion factors working on the large over floating metallic constructions built for this activity. The large amounts of organic matter derived from duck wastes containing TDZn participate in the increase in TDZn through phytoplankton recycling. The zonal distribution of TSM in the lake was limited. The feeding canal seemed to be not the main source of TSM, confirming existence of another source of TSM for the lake. The TSM peaks in spring and summer prove the biogenic TSM origin. It seemed that most of Zn in the lake, especially the inorganic forms, reached its water via anthropogenic sources and TPZn dominated the TDZn. A positive regression equation existed between TSM and TPZn; $TSM = 24.483 \pm 4.27 + 0.04 \pm 0.02$ TPZn ($r = 0.354$, $p < 0.013$). This illustrates that the bulk of TSM was composed of TPZn plus other contributors. The seasonal TPZn peak in April in the lake and its feeding waters increased the annual mean concentration for the lake. The very high TPZn scored in April in front of the feeding canal reflected these spring peaks and mostly resulted from garbage wastes and letter dumped into the uncovered feeding canal.

Keywords: lake, suspended matter, dissolved zinc, particulate zinc, Egypt.

Social constrains for restoration of arid shrub steppes in Northern Patagonia (Argentina)

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Cattle raising and oil/gas exploitation are the two major degradation factors of arid ecosystems in Patagonia. Scientific and technological solutions seem to be not enough to restore them due to the people's acceptance risk to perform sustainable management and rehabilitation techniques. In order to explore these constrains, we investigated the social framework and awareness to nature degradation/restoration of the Monte Austral ecoregion (Neuquén and Río Negro provinces), by means of deep interviews and legal/social analyses. We determined four major interest groups (stakeholders) responsible for the problems and their solutions: public agencies (G1), research & management institutions (G2), livestock farmers (G3), and private companies (G4). According to the influence of the decision making on environmental management and policies, the relative importance of each group was: G1 >> G2 > G4 (G3 has almost no participation), whereas the ranking according to the degradation effects on socioeconomic benefits was: G3 >> G4 > G2 = G1. As a result, the higher the restoration needs a social group has, the lower is its decision-making capability to promote changes. Three major causes explain these results: the precarious land tenure status of most farms (circa 90%), the confusing legislation for environmental management (lack of specific standards, confusing concepts), and the low general public awareness. Solutions to overcome social constrains strongly depend on changes in policy mechanisms and in public's perception of ecosystem degradation. We propose four basic measures: immediate reduction on land tenure complexity, inclusion of public's direct participation in the decision making process, development of educational campaigns, and enhancing the application of legal and technical regulation.

Keywords: cattle raising, oil companies, stakeholders, ecosistem degradation, social risk.

Some aspects of phytophilic faunas formation and its production in reservoirs-coolers

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We have studied phitophilic fauna of 2 reservoirs of coolers thermoelectric power station with turnaround system of water supply, the oldest in Russia, constructed in 1924-1925. The reservoirs settle down In the Moscow and Nizhniy Novgorod region (57º N). Both reservoirs - coolers are created on the basis of small lakes and small rivers closed in a ring form uniform reservoir. In it excavations on increase in capacity of a reservoir have been carried out. Thermal water of thermoelectric power station is dumped In reservoirs. In reservoirs warmed-up (3,0-32,0 º C) water heat-electric generating station is dumped. For 80 years period of the existence there was a restoration broken by the person water ecosystem, consisted of a circuit lakes and small rivers. Ecological succession in the given reservoirs has got specific features:1) Process of overgrown with macrovegetation went faster, than in natural reservoirs, associations of southern water plants have appeared, 2) Indigene northern fauna has been began influence of high temperatures for it. However it has not disappeared. In reservoirs the southern species unusual for the given northern latitude of exploration were installed. It is revealed seven northern and five southern coexistenced phytophilic invertebrates species formed steady populations, 3)Highly productive phytophilic community with a high species variety is created, 4) Reservoirs-coolers have quickly passed serial stages and now are close to a condition of "climax"

Keywords: phytophilic community,thermal water, fauna, reservoirs-coolers.

Experiences in ecological restoration of pyrite mining areas of southern Spain

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In 1993, the Environment Agency initiated a series of projects with the joint funding of the European Union –through FEDER funds- and the Government of Andalusia in order to mitigate the contamination resulting from the abandoned mining activity that occurred in the geological formation known as the "Pyrite Belt". The different restoration actions that were implemented in 20 mining areas included the mining waste withdrawal and sealing, mining wells sealing, perimeter drainage control channels and calcareous traps for water pH control purposes. In order to complete the mining impacts correction, a sec-

ond phase consisting of landscape integration and soil restoration activities was initiated. According to this, a series of experimental plots were established in 1998 in order to study the revegetation ability of soils affected by acidification processes derived from the mining activity, applying different claiming treatments for soil restoration and different plant species for revegetation. Later, in order to determine the most adequate plant species and soil treatments, the causes of plant mortality, the efficiency of the corrective treatments on soil conditions and the effects of heavy metals accumulation on plants, soil and vegetation samplings were conducted. As a result, a series of threshold levels for vegetation establishment in these extreme environments were defined. Additionaly the obtained results show satisfactory adaptation of some of the species that were considered (*Pinus pinea, Pinus pinaster, Cistus ladanifer*) to acidic systems. Likewise, the incidence of soil parameters, pH and iron on the availability of heavy metals and arsenic and its absorption by plants are shown.

Keywords: Phytotoxicity, pH, vegetation response, soil response.

Water availability and morpho-functional traits in Mediterranean grasslands

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In mediterranean grasslands, soil water availability varies regionally (with altitude) and locally (according to geomorphology). Environmental conditions determine well known patterns in floristic composition and associated morpho-functional traits (MFTs). The aim of the present study is to analyse the relationship between water availability and relative abundance of MFTs. Five locations along an altitudinal gradient of 1200 m were sampled in Central Spain. In each location, two 160 m^2 plots were set up on the upper and lower part of a south-facing slope. Relative abundance of 53 MFTs in each plot was evaluated as the number of species that presented a given trait. The first axis of a Detrended Correspondence Analysis explained 64% of the total variance. The axis was related to the altitudinal gradient and revealed an ecological persistence trend: gradual change from ecological strategies *r* (lower altitude) to *K* (higher altitude). A pattern in water availability is investigated experimentally in two extreme temperature conditions as a function of water evaporation process, and was related to the ecological persistence trend. Results showed that parameters of the evaporation process that affect the ecological trend depended on temperature setting: when it was high, water stress in soil led to *r* strategies, whereas when it was low, total duration of the evaporation process determined strategies type *K*. These patterns of variation allow to adequate restoration practices in Mediterranean grasslands and to predict the consequences of various scenarios of climatic change.

Keywords: altitudinal gradient, ecosystem function, water stress, geomorphological influence, land use.

Effect of nitrogen and phosphorus addition on leaf growth, senescence and nutrient content of *Juncus maritimus* in a brackish marsh

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Eutrophication decreases diversity of ecosystems. Natural systems of the Ebro Delta are strongly affected by nutrient rich freshwater discharges from rice fields and the river. In Garxal marsh (Ebro Delta, NE Spain) a displacement of *Juncus maritimus* by *Phragmites australis* was observed during the last ten years. In order to understand the effects of nitrogen and phosphorus on the growth cycle of *J. maritimus* and its potential use for brackish marsh restoration, nutrients were added experimentally to plant tussocks to determine their effects on leaf growth, senescence and nutrient contents. A positive effect of N, P and N plus P was observed on leaf growth. The effect was higher in leaves budding at the beginning of summer than in leaves budding at the beginning of spring. Both N and P contents in the leaves increased in fertilised treatments. Senescence and death of *J. maritimus* leaves proceeds from the leaf tip to the base following an exponential model. Senescence rate was higher in leaves tagged in April than in leaves tagged in June. Significant effect of fertilization was observed in the leaves tagged in April increasing senescence rate under P and N plus P treatment. In the leaves from the June cohort only significant effect of P addition on mortality was observed. Seasonal differences were observed on leaf fall under different nutrient additions. Addition of N and P increased leaf fall, an 80% of tagged leaves became detached at the end of the senescence, whereas only a 45% were fallen in the unfertilised plots. These results indicate that brackish marsh restoration can not rely on re-establishment of hydrologic connectivity only but also on nutrient reduction because increasing landscape diversity by establishing an environmental gradient from fresh to salt water may be counteracted by the diversity decrease effect associated to increas-

ing nutrient rich flows into marshes. Knowing the effects of nutrient fertilization on population dynamics is a key tool for habitat restoration of marshes submitted to fresh and marine discharges.

Keywords: brackish marsh, restoration, nutrients, emergent macrophytes, growth, senescence.

Potential utilization of *Cistus ladanifer* L. in mining revegetation

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Mining and smelting can produce large quantities of volatile and dust particles, which contain high concentrations of trace metals, and may contaminate soils, waters and vegetation. These levels of trace metals are found in and around the mines due to the discharge and dispersion of mine waste materials into the ecosystem. Establishment of vegetation cover is essential to stabilize the area and to minimize both physical and chemical environmental impacts. The use of resistant flora can be a strategy for the recovery of areas with high content of trace metals and with economic interest. *Cistus ladanifer* L. is found in a wide range of latitudes, altitudes, climate, and soil types, and it has a large capacity of adaptation to sites with different levels of degradation. This investigation focuses on the possibilities of revegetation of waste materials in mining areas using *C. ladanifer* to minimise the impacts of the mining activities. *Cistus ladanifer* seeds and leaves with different development stages (young, mature and old), growing on waste materials from an abandoned copper mine of São Domingos, SE Portugal were collected. For comparison, the same parts of the same species were also collected in a non-contaminated site, Serra do Caldeirão, South of Portugal. Total As, Cu, Hg, Pb and Zn were analysed in leaves and seeds of *C. ladanifer*. Total chemical analyses, as well as the available fractions of As, Cu, Hg, Pb and Zn were carried out on waste materials and soils. The obtained results for plants, soils and waste materials were correlated.

Keywords: *Cistus ladanifer*, revegetation, phytoremediation, mine spoil.

Effects of watering and fertilization on the quality of nursery-grown *Quercus* seedlings

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We look for the fertilization and watering level that optimise plant seedling growth and starch storage in three Mediterranean oaks (*Quercus)*: *Q. coccifera* (QC), *Q. ilex* (QI) and *Q. faginea* (QF). The experiment consisted in three levels of fertilization (5, 50 and 200 mg of N per plant and growing period) and three of watering (36, 58 and 67% of soil field capacity). Treatments were applied to current-year seedlings between May and October. 4-10 seedlings per species and treatment were harvested in May and in October to calculate biomass and relative growth rate. Plant starch content was assessed in 5 seedlings in October. Moderate fertilization increased the total amount of starch per plant in QI and QF, although its effect on starch concentration was positive in QI and negative in QF. QC showed no response. The highest fertilization decreased both the total amount and the concentration of starch in the three species, probably due to toxicity. QF increased both the amount and the concentration of starch to increasing levels of watering, QI was negatively affected by high watering, probably due to root anoxia, and QC showed no response. Moderate levels of both resources maximised simultaneously growth rate and starch storage in all cases, except in QF, which exhibited highest growth and starch storage in high watering. We conclude that the optimum nursery treatment should be assessed for each species, and that large plant size may be accompanied by low starch reserves, which makes them more vulnerable to transplant shock and habitat-induced stresses.

Keywords: seedling quality, starch reserves, RGR, fertilization, irrigation.

Integrating ecological restoration with biodiversity conservation in a high diversity region: The Transvolcanic Belt of Central Mexico

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Existing methods for the design of conservation area networks (CANs) are extended to: (i) augment connectivity in networks using techniques from graph theory; and (ii) incorporate multiple design and socio-economic criteria. This approach is illustrated by developing a plan for the conservation of biodiversity and potential ecological restoration in the Transvolcanic Belt of central Mexico. An iterative place prioritization algorithm based on rarity and complementarity was used to select sites with untransformed vegetation that include 10 % of the habitat of each of 99 non-volant mammal species which are used here as biodiversity surrogates. External sites were then identified to link conservation areas to facilitate migration or egress of biota in the event of local environmental catastrophes. These external sites were those that would be selected to represent biodiversity surrogates at higher percentage targets. Thus, these are sites for potential ecological restoration. The most economical sets of contiguity areas needed to link all conservation areas were identified using graph-theoretic protocols. The network constructed ab initio required 6.02 % of the regional area whereas the network initialized with existing protected areas required 9.13 %. In both cases, an additional area of only about 1.5 % of the region would be required to establish minimal connectivity. Finally, a multiple criterion synchronization technique was used to select those connected networks which best simultaneously optimized: (i) uniform connectivity; (ii) low total area; and (iii) low human population impact

Keywords: connectivity; ecological restoration; graph theory; Mexico; reserve selection; Transvolcanic Belt.

The Leaning Tower of Pisa, Modern Art, and the accidental rainforest: lessons in creative conservation and environmental justice

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It is the business of nature conservation to respect past events and assemblages of species, and yet nature itself is about opportunity and responding to change. In a changing world we need to be able to react positively and practically to circumstance in order to deliver landscapes that have ecological worth, scale, and sustainability. This poster features two simple tales from the real world, and highlights practical examples of how to turn the tide of relentless environmental degradation, by innovative approaches and inspirational project work. Sometimes it is about stepping outside of conventional wisdom, and trying new approaches to old problems. It can be about turning things on their head, more often it is about trying different solutions, building upon past good practice and inspiring others to follow. It is also about addressing the problem of the ecological poverty of the land outside nature reserves and biodiversity hotspots, in places where the majority of people actually live; delivering environmental justice and raising people's aspirations about what is possible. Above all it represents a creative pathway that relies as much on cultural wisdom, artistic thought and common sense as good applied ecology.

Keywords: Leaning Tower of Pisa, nature conservation, past events, artistic thought, landscape.

Restoration of lake ecosytems–A Case study

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Increasing population and human activity pressures are wreaking greater degradation of natural resources, and damage to the environment and ecological system around the world. Increasing intensities of industrial, agricultural and recreational activities have contaminated lake waters, thereby jeopardizing the health of the ecosystem and threatening its sustainability. In the recent decades, greater public awareness of environment degradation has prompted demands for conservation and restoration measures and pollution abatement practices. That these have not been forthcoming to a sufficient degree on a voluntary basis has been the catalyst for rising number of calls for public interaction and participation. Surveillance of water quality parameters of lakes, especially with urban catchment is very essential to have a clear idea of the state of eutrophication and to restore the lake ecosystem from further deterioration. The present paper presents the results of such study carried out on Bhadri tank, which acts as the summer storage tank for the augmentation of Warangal Water Supply from the

Kakatiya Canal. Some of the restoration techniques applicable for the Bhadri Lake ecosystem are discussed in the present study.

Keywords: Ecosystem, lake restoration, water quality management, urban landuse, source control.

Effect of buffer strip on species diversity in the immediate surroundings boreal brook habitats

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In Finland, ensuring biological diversity in the forests is taken into account in both Forest Act and in the Nature Conservation Act. In the Forest Act, certain key biotopes have been defined as habitats of special importance, where rare and demanding species are expected to occur. These habitats will be left out of aggressive forestry operations. In our studies, the main focus is on the width and age of the buffer strip around brooks. Studies are conducted in the boreal coniferous forests in Finland by studying vascular plants and mosses (Bryopsida). We found that the plant species community in the vicinity of brook was affected by the interaction of time since harvest and the width of the buffer strip. Number of species declines with time since harvest and the decline is most drastic in the most narrow buffer strips. Moss species in the vicinity of brook were also affected by the width of the buffer strip. In the vicinity of the brook there occurred more rare moss species than further from the brook. In the wider buffer strips, both moss and plant species communities in the vicinity of the brook remained rather constant trough the time. We conclude that wide buffer strips can prevent the effects that harvesting has on species communities on the immediate surrounding of the brook as well as ensure and restore habitats of special importance.

Keywords: Boreal forest, buffer strip, diversity.

Germination of seeds of some shrubby plants used in the revegetation of ski slopes of Sierra Nevada (S Spain)

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The works of conditioning and opening of new facilities in the ski station of Sierra Nevada (S Spain) has seriously altered the landscape, an area of great floristic importance and very rich in endemic species. Therefore, restoration work is indispensable in this zone. Previous laboratory studies on the germination of seeds from plants growing in the surroundings of the ski station indicated that certain growth regulators substantially increased the degree of germination in the species studied. According to the data compiled, an experiment was performed under controlled conditions with seeds of the following endemic species of the Betic Sierras: *Genista versicolor*, *Hormathophylla spinosa*, *Reseda complicata*, and *Thymus serpylloides* subsp. *serpylloides*. Seeds were pretreated for 12-24 h with different regulators, according to the cases, and afterwards sown in three types of different soils of the ski zone. The conditions were 15°C day/4°C night temperatures and a photoperiod of 12 h. For 60 days, the evolution of the germination was followed. Although the results were not very satisfactory, fundamentally with relation to the untreated seeds, in general, the pretreatments tested provided results that substantially exceeded the degree of germination reached by the respective controls. In this sense, it bears highlighting the increases that resulted from applying Ethrel 10 ppm, 12 h in *Genista* (33% against 9% control); Benzyladenine 10 ppm, 12 h in *Hormathophylla* (30% against 9% control; Benzyladenine 10 ppm, 24 h in *Reseda* (44% against 23% control; and Inabarplant IV 10 ppm, 24 h in *Thymus* (36% against 6% control).

Keywords: Endemic species, germination, plant growth regulators, revegetation, ski slopes.

Is allelopathy a driving force in forest succession?

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Allelopathy is a major research subject in chemecology, it studies the relationships between the biology and abiotic environment. Since 1960s, several scientists have studied the allelopathy in relation to plant ecology. Now most researches are being done on herbaceous plants and few on woody plants, because of their long lifecycle and slow response to allelopathic substances. Hence, we studied the dynamics and role of allelopathy in forest ecosystem. The traditional ecological theory states that the main driving

forces in forest succession are light and water. However, our results of more than 20 years of fieldwork on six major tree species (*Cryptocarya chinensis, Cryptocarya concinna, Schima superba, Castanopsis chinesis, Caryota ochlandra* and *Castanopsis fissa*) of Dinghu mountain showed that a) all these test species contain allelochemicals, b) allelopathy affects the succession among these species and c) allelopathy play important role in forest succession. Thus we put forward a hypothesis that allelopathy, light and water, may be considered as the major driving forces in tropical and sub-tropical forest succession.

Keywords: Allelopathy, cabbage *Castanopsis chinesis, Castanopsis fissa, Caryota ochlandra, Cryptocarya chinensis, Cryptocarya concinna*, cucumber, forest, *Pinus massoniana*, radish, *Schima superba,* succession.

The Sunshine Coast compensatory habitat project

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Australia's coastal heath contains many endangered, vulnerable or rare (EVR) plant species but is rapidly being lost due to coastal urban expansion and human population growth. Developers are now being required to compensate for this loss. An innovative collaboration between local council, property developer and University attempted to take a comprehensive and scientific approach to minimise the loss and ensure the best compensatory habitat created. The development site contained heath and wetland habitat for several rare animals and populations of five EVR plant species. Thus species assemblages present on the site that were known to provide habitat for the rare animals were required to be compensated for as well as the habitat and populations of the EVR plant species. A rehabilitation code was developed which specified measurable performance objectives, a compensatory habitat plan was developed to outline the methodology and on site works and additional studies are being undertaken on the population genetics and ecology of the EVR plant species that were poorly known. The project will translocate entire intact turf's (soil plus vegetation) from the development site to a nearby previously cleared site located on the USC campus and will be oriented to capture the EVR species and reflect the original proximity and landscape/topographic position and thus translocating whole populations including soil stored seed banks. Supplementary seed and cutting collections were made from the EVR populations to enable the translocated populations to be supplemented if required. The approach taken ensured success would be measurable and ecologically based.

Keywords: Compensatory Habitat, habitat fragmentation, threatened species, performance objectives, coastal heath.

The influence of different barrier constructions of tailings impoundments on infiltration rate and water balance - experimental studies from Kristineberg, Northern Sweden

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The application of soil covers, most often consisting of a low permeability barrier, has become an established reclamation method for decommissioned mine waste deposits in Sweden. However, there are alternative cover systems that have been suggested to be more efficient. In order to test the performance of different covers a field-scale study has been carrying out within the Georange Project. Six 5*5*3 m^3 concrete cells constructed at the Kristineberg mine site, Northern Sweden, have been filled with sulphide rich mine tailings. Clayey till, sewage sludge, Trisoplast (a mixture between a polymer, bentonite and tailings sand) and fine-grained apatite are used as sealing layers and on that a protective cover of unspecified till has been applied. In one reference cell, uncovered tailings have been left open. The experimental soil covers have been monitored for 2 years for percolation and water-infiltration data. Besides observation of water flow through different barriers, soil temperature profiles are measured. To be able to evaluate the behaviour of the multilayer cover the climate conditions (precipitation, snow accumulation, air temperature and humidity) are monitored as well. For an accurate prediction, on tailings impoundment scale, how the different barrier constructions influence infiltration rate and water balance, is important to determine the water balance in each cell (water in, water out, storage in the cell) and explain the different infiltration rates in different cells (explain how the different barriers influence the infiltration rate). The preliminary results will be presented and discussed.

Keywords: reclamation, mine tailings, cover.

Assay of native shrub recovery in the burned area of Puerto de Las Palomas (Cazorla Segura y Las Villas Natural Park)

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In an ongoing research project, we are designing the restoration of natural vegetation in the burned area of "Puerto de Las Palomas, Cazorla (August, 2001). The history of human management in the territory, together with severity of fire led to the loss of native vegetation. Based on processes naturally occurring in Mediterranean vegetation dynamics, we are implementing management practices aimed to accelerate the successional process. As a part of the design of an intermediate, 'building phase', in the succession, we are assaying planting techniques optimizing establishment of serial shrub species of native vegetation. Assays are being conducted in areas with four potential mature vegetation types: holm oak, pine and gall oak forests and ravine vegetation. We set four 10 x 10 m large-mammal exclosures at each vegetation type and planted four shrub species within each exclosure. The experimental design considers the effects of irrigation during summer (irrigation versus not irrigation), seedling mycorrhization (mycorrhization versus no mycorrhization), and propagule type (seedling versus seeds). Generalized linear mixed models were fitted to the data using seedling survival probability as a binomial response. We found an additive increase in establishment of seedlings with irrigation and mycorrhization.

Keywords: Restoration; seedlings; successional process.

Ecological restoration priorities in an ecological network framework

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The purpose deals with the implementation and first application of a model aiming to recognize ecological restoration priorities in an ecological network framework. The geodatabase sources used were: Master Plan and information provided by Land Reclamation Consortiums; floristic surveys; real and historical aerialphotographs and field surveys. First, we grouped the data sources to make only one grid theme concerning land use, then we selected, from the floristic geodatabase, two functional groups that we supposed to form metapopulations and to be subjected to isolation and rarefaction: forest and wet area plant species. We mapped all the meadows and we considered them as potential sources of meadow plant species. We assigned to every land use types, for every functional group, a roughness value (their power to limit plants dispersal and colonization, ranging 1-10). We calculated, adopting ten classes, Euclidean distance from the population of the selected plant species, identified from the floristic geodatabase. Finally, we calculated the impermeability (the product between roughness and distance, weighting the first 0.7, the second 0.3). We extracted the priority cells (2 m x 2 m) from cells whose impermeability was less than 8, those that were within public accessible properties and within 500 m from cultural rural anthropic elements (old farmhouses, pumping stations, capitals). The results were the precise mapping of the areas where is most probable a colonization of the three functional groups of plant species, together with effective possibility to access and with rural cultural interest. Further researches could deal with the addition of other variables to the model.

Keywords: ecological networks, restoration ecology, flora, geodatabases sources, decisional models.

Internal metal distribution in sediment pore water, water system of some bights at Nasser Lake, Egypt

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A fate and bioavailability of pollutant metals is important to the long – term health of freshwater. The main objective of this study aimed to follow up the distribution of some heavy and major metals (Fe, Mn, Zn, Pb, Cd, Co, Ni, Cr, Cu, Ca, Mg, Na and K) between sediment – pore water – water system of some bights of Nasser Lake. Sediment and water (surface and bottom) samples were collected from the beginning and the end of three bights at Nasser Lake, Egypt. All studies metals were measured using atomic absorption technique except Na & K were analyzed by atomic emission spectrophotometry. Water quality variables were monitored at surface and bottom water. Chemical partitioning patterns of metal show decrease in concentrations of measured metals in sediment (in exchangeable fraction), reflect the decrease of pore water contents, wherefore the water body characterize by low metal concentrations. The alkaline pH-values of water bights minimize the reflux of metal ions from lake sediment and increase of metals

sedimentation rate. The application of Pearson correlation approaches for the interpretation of large data matrix obtained was performed using SPPS statistical package program. Positive correlations were arise between different metals in pore waters and lake water suggesting that, sediment upper layer served as a metals reservoir from water, but not as an ultimate mechanism to control metal concentrations in the adjacent water. Also these correlations between components give chance to follow the distribution of measured metals between sediment – pore water – water lake system.

Keywords: Sediment, pore water, water system, Internal metal distribution, heavy metal, bioavailability, Nasser Lake.

The ecological restoration of salt meadows in the shores of Gallocanta Lake (Aragon, NE Spain)

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Salt meadows mostly dominated by the endemic species *Puccinellia pungens* (Pau) Paunero (*Poaceae*, Gramineae) cover the shores of the saline Lake Gallocanta (Teruel-Zaragoza) at 950-105 m. altitude. These meadows have been degraded (soil drained, plants removed) historically by extensive agricultural works developed to extend agricultural fields. A number of actions were developed as part of the Life Project ReCoGeSAL to restore *Puccinellia* salt meadows during 2000-2003. They included: Purchase of land, technical experimentation to check techniques for the restoration of *Puccinellia pungens* meadows, assessment of the techniques experimented, information and dissemination of results. Land was purchased in the shores of Gallocanta Lake based on availability for purchasing, representative characteristics and requirements for restoration. The experiment to test restoration techniques performed in 3m*3m experimental areas showed that spontaneous colonization and growth of *P. pungens* is more efficient that more complex techniques used including soil reposition and soil fertilization. After 3 years of treatment, the coverage and density of *Puccinellia pungens* plants were higher in treatments with spontaneous colonization than in the other treatments, where other invasive species developed better. This is most probably due to the high competitiveness of *P. pungens* in extreme environmental conditions (hard and poorly developed soils, salt zones with water level fluctuating conditions). Results have been disseminated in different ways (newsletter, Internet) but lack of programs of interest prevented integration of results at local scale.

Keywords: Puccinellia pungens, saline, meadows

Assessing the functional development of ecosystems associated with restored minesoils at the Alcan Gove minesite, Nhulunbuy, Northern Territory, Australi

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This study evaluated ecosystem restoration success in native forests established after bauxite mining in tropical Australia. Study sites were selected within a 26-year chronosequence of ecosystems and the developmental trajectory evaluated in relationship to reference native forest ecosystems. Fire was excluded from the rehabilitated forests. Developing ecosystems progressed through phases of grass-dominance (1-6 y), increasing shrub dominance (6-12 y), canopy closure (ca 12y) and a continuing period of maturation and thinning associated with increasing canopy dominance by Eucalyptus species, largely E. tetrodonta. The herbaceous and litter layers developed rapidly with near-complete closure by ca 3 years. Dominantly grassy litters gave way to broad-leaved litters at ca 10 years. Litters were thick and layered; maximum mass was ca 3 kg m-2, three times that of adjacent regularly-burned native forests. Soil C concentrations increased sigmoidally and surpassed concentrations in a native forest reference site after 14 years. The CEC, pH and exchange properties were all closely correlated with C concentration. The restored ecosystems are developing many of the attributes of the local native forest ecosystems but their reaction to fire is little known.

Keywords: bauxite mining, restored ecosystems, ecosystem development, Eucalyptus tetrodonta.

Study of reproductive biology of *Fraxinus ornus* through artificial pollinations and its impacts on population genetic evolution

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Reproductive biology of forest tree species is a fundamental research upon which genetic variation studies and sustainable utilization of genetic resources are based. The present study refers to pollinations applied to the tree species *Fraxinus ornus* and includes the following treatments: a) selfing (S), b) cross of hermaphrodite (functionally female) with male (HM x M), c) cross of hermaphrodite with hermaphrodite (HM x HM), and d) open pollination (OP). Totally, 210 artificial crosses were carried out on *F. ornus* trees of Chortiatis population (Thessaloniki) using special pollination bags. Parameters recorded were the following: mean number of seeds/infrutescence, mean seed weight and germination percentage of each treatment. The results of pollinations demonstrated that selfing (S) produced much less seeds/infrutescence (e.g. tree 9, mean 5.0 seeds/infrut.) in comparison to the other treatments (mean 150.0 - 125.6 - 167.2 seeds/infrut., for HM x M, HM x M and OP, respectively). On the opposite, treatments HM x M and OP gave the highest number of seeds/infrutescence in most trees. Results showed no significant differences in seed weight (g/seed) among treatments across all trees, and in cases for the same tree (e.g. tree 8, mean 0,024 - 0,023 - 0,024 - 0,025 gr/seed, for S, HM x M, HM x M and OP, respectively). However, significant differences were found for the seed germination percentages (%) with lower values for selfing (e.g. tree 8, 10.0%) compared to other treatments (78.7% - 80.3% - 85.0%, for HM x M, HM x M and OP, respectively). This study demonstrated that selfing has a smaller role in species reproduction and may results in inbreeding, but it can be important in colonizing new lands and species evolution.

Keywords: *Fraxinus ornus,* reproductive biology, pollinations, selfing, inbreeding, evolution.

Defining priority areas for enhancing species richness by modelling "hotspot-suitability"

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Agri-environmental schemes, as they have been developed in many European countries, are a possible way to enhance agro-biodiversity. In Switzerland, farmers therefore have to convert 7% of their farmland into low-input habitats, so-called ecological compensation areas (ECA). In order to optimize the efficiency of the scheme, the ECAs should be situated in the most appropriate areas, and there on the most suitable sites. In this study we developed a management-independent method for selecting communities with high responsibility for the species richness of a selected indicator-taxon, and for identifying the sites with the highest potential species richness. Within a biogeographic unit in Switzerland, we modeled "hotspot-suitability" at a resolution of 1 ha by a presence-only model. Hotspots are defined here as the plots with highest numbers of grasshopper species. Based on this model we were able to identify those municipalities that have the highest responsibility for grasshopper species richness. Within these municipalities, the most suitable sites for conserving or enhancing species richness, i.e. by fostering the establishment of ECAs, were defined. The selection-procedure as well as chances and limitations of this approach are presented and discussed.

Keywords: Priority areas, ecological compensation areas, habitat suitability model, grasshoppers.

Re-meandering of an agricultural stream, Southern Sweden

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During the last 150 years a large number of agricultural streams in Sweden have been excavated and ditched. The river Smedjeån is such a river, and the municipality of Laholm and REAS have restored a 4-km stretch of the stream. One obstacle to overcome in restoration projects involving streams is conflicting landowner interests. In order to decrease this foreseen problem, large efforts were spent on individual information to every landowner along the stream. The planning of the project was done in close co-operation with landowners and they had a considerable influence on the final design of the re-meandering. The project was constructed in different parts, where we started with the construction of 40 hectares of ox-

bow lakes, wetlands and ponds along the stream. The ox-bow lakes where placed and constructed so that they could become the new riverbed in the final steps of re-meandering the stream. The rationale for doing this was that the project would not be a failure if the actual re-meandering was inhibited by legal factors or landowner disagreement. In that case the areas would still function as a "wetland landscape" with a large potential for attracting both the wildlife and the public. Viewpoints, tracks and information signs for the public have been constructed. So far the project is a success according to landowners, anglers, birdwatcher and the general public.

Keywords: Re-meandering, landowner influence, biodiversity, public use.

Applicability of species groups as indicators of restoration efficiency in sandy old-fields

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Species number or diversity indices are usually inappropriate measures for detecting the efficiency of restoration treatments in species poor ecosystems, as these values might increase with degradation processes. Recently a species-group system was developed based on field experience, that reflects the ecological demand and traits of vascular plant species typical for the Kiskunság region of Hungary. We used three plant traits of this category system to evaluate the success of various methods applied at old-fields in order to direct secondary succession towards the open sand grassland. The selected traits include habitat preference, disturbance tolerance, and species origin, with reference to conservation values and functions of species in the sandy grassland ecosystem. Our hypothesis was that species groups are more sensitive indicators of naturalness than the simple species number aspect of biodiversity. We analysed vegetation data from two restoration experiments. First carbon amendment was applied between 1998-2003 at three sites on the same old-field. The second one started in 2002 at three old-fields of different ages which were ploughed again and afterwards the effect of carbon amendment, mowing and seeding was tested in microplots. In accordance with our hypothesis, species groups made by combining the three plant traits revealed minor vegetation responses that were not detectable by species number, like the supression of indigenous weed species in the first, and that of non-indigenous weeds and invasive species in the second experiment. It is concluded that the use of multiple methods for data analysis is required for detecting restoration efficiency.

Keywords: Species groups, biodiversity, secondary succession, sandy grassland.

Consequences of organic C addition on soil microbial biomass and activity in abandoned sandy fields

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We have applied different carbon sources to enhance immobilisation of soil nitrogen into microbial biomass in order to accelerate the re-establishment of the native grasslands on abandoned fields in the sand dune area of the Kiskunság National Park (Great Plain, Hungary). The rationale is that large soil inorganic N concentrations, arising from previous land use, have limited re-establishment of the native grassland. Sucrose and sawdust were used at three sites in various relief in the growing seasons for six years. Nitrogen availability, especially nitrate-N concentrations, have been significantly reduced due to the C amendments. Soil microbial biomass C contents were estimated by chloroform fumigation incubation (CFI), chloroform fumigation extraction (CFE) and substrate induced respiration (SIR). The C treatments led to increased SIR in all sites, increased CFI, CFE and soil respiration at least in two sites in many cases. These results show that the combined and repeated C treatments in the field can increase the soil microbial biomass in a short time and the elevated biomass can be maintained for a long period indicating N immobilisation indirectly.

Keywords: N immobilisation, microbial biomass, sucrose, sawdust, Kiskunság, restoration.

Restoring protected wetlands affected by lead shot pellets accumulation in Alicante, Spain

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Lead poisoning as a result of ingestion of lead pellets in wetlands has been a major cause of waterfowl mortality. The purpose of this study was to develop a diagnosis of overall lead accumulation in the sediment and soil and to calculate the density and distribution of available lead shot pellets for waterfowl in selected lagoons and ponds of the most relevant protected wetlands of Alicante (SE Spain): El Hondo Natural Park and Salinas de Santa Pola Natural Park. Core samples of 10 cm of depth were collected with a PVC tube (N_H=2.030; N_{SP}=303). We used Inverse Distance Weighted, a deterministic interpolation technique, in order to map lead shot densities. Mean shot density in the 10cm column was about 57,3 shot/m^2 in El Hondo and about 45,4 shot/m^2 in Santa Pola, but the highest densities found were about 891 shot/m^2 in El Hondo and 1.145 shot/m^2 in Santa Pola. These densities were higher than those described in other Spanish wetlands such as the Natural Parks of the Ebro Delta and L'Albufera de València, where there are as many as 266 and 287 shot/m^2 respectively. Total lead accumulated in the 10 cm column in the studied ponds was about 53 t in El Hondo and 5 t in Santa Pola. Lead shot should be extracted by mechanical methods to reduce lead poisoning. As a result of this study a restoration project has been carried out in a Natural Reserve area in El Hondo, where it has been extracted the surface of sludge in the lead shot polluted areas.

Keywords: Lead poisoning, lead, pellets, wetland, Natural Park.

The University Regional Consortium (Moldavia) for environment monitoring and protection - as a premise for the optimization of living conditions and life and for student service improvement

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At "Alexandru Ioan Cuza" University of Iaşi, Romania, a project has been implemented in 2004 by creating an organizational structure named *Regional Research Consortium (Moldavia) for Environment Monitoring and Protection* ("Consorţiul de Cercetare Regional de Monitorizareşi Protecţie a Mediului" – C.C.R.M.P.M.). As an initiator, promoter and coordinator of CCRMPM, I have succeeded to attract in this consortium 14 education and research institutions (i.e. 6 faculties from 3 universities and 2 research institutes, 4 research units, a museum and a botanical garden) both from our city and from other parts of Moldavia, as well as students from our Faculty of Biology - specialized in Biology, Ecology and Biochemistry - and from our Faculty of Geography and Geology - members of the *Romanian Students' Association of Young Ecologists (Asociaţia "Tinerii Ecologi Români din Iaşi" – T.E.R.IS.)*. This has become a beneficial partnership from the points of view of the research cooperation concerning the ecological restoration and environment monitoring and protection and of the social services put at the students' disposal due to their affiliation to a higher university structure. For the future, my intention is to widen the cooperation of our University Consortium with the Romanian branch of the Balkan Environmental Association (RO – B.EN.A.) and, together with other international bodies, find further financial support with a view to offer more and more students better motivation and opportunities to involve in our joint projects on ecological restoration.

Keywords: regional consortium, environment, ecological restoration.

Base factor on Home Ranges

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Home Ranges (HR) was defined by Burt as the area transverd during the natural activity of food gathering, mating and caring for young and this definition is still widely used. But this definition is not factor on HR. I found Base Factor on HR, when the smallest changing on BF changing widely in other factors on HR, thermal condition, mates, body size, and so on are not BF. Three, biome in Iran Plateau was studied ecological, climatically and geographical in varying selected station. Then, for the testing of survey on the station and conditions, used the Correlation Regression and Cluster Analysis, in the results was obtained decrease of station and Varity of sauria in this plateau. Then survey of changing in food on the sauria and Population condense*eggs numeral and relationship these factors with the source of nu-

trients along with condense and variety of floristic was caused that, HR of sauria divide in two groups. In according to the results of static analysis diversity in the dispersal is limited by characters of each ecosystem. First group widely area (dispersed on variety biome) and second group dispersed on only biome. The most important factor in the area of HR is Variety*Condense of floristic in the area. Because of the smallest change in this factor change HR of sauria widely.

Keywords: Home Range, base Factor, lizards.

Establihment of mesquite plants (*Prosopis laevigata*) inoculated with arbuscular mycorrhizal fungi under water stress in greenhouse conditions

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Mesquite (*Prosopis laevigata*) is a "nurse plant" that form "resource islands" in semiarid ecosystems in Central México; the adult plant (shrub or tree) favors plant succession in natural communities, nevertheless, mesquite establishment is a critical period in restoration programs. For this, the objective of this work was to determine the effect of arbuscular mycorrhizal fungi (AMF) on establishment of mesquite plants under water stress conditions. The experimental design was an analysis of variance of two factors: soil irrigation and mycorrhizal treatment, with two levels each one: wet and dry watering (W, D) X AMF inoculated and non-inoculated pots (M+, M-). We used 20 repetitions in each treatment. The source of AMF spores, *P. laevigata* seeds and soil was a semiarid ecosystem at the "Valle del Mezquital", in the Hidalgo State. Mesquite seedlings were grown on stelirized soil for 6 months under greenhouse conditions.The results show that Reproductive Growth Rate and Water Use Efficiency (dry biomass/irrigated water) of AMF treatments was significantly higher than non-mycorrhizal plants. Also, the caulinar water potential of mycorrhizal plants was lower than their controls; moreover, establishment and survival of mycorrhizal plants were higher than their witness. Therefore, it was concluded that AMF inoculation of mesquite seedlings is a useful tool for increase the plant establishment in restoration programs for degrated semiarid ecosystems.

Keywords: Plant establishment, *Prosopis laevigata*, arbuscular mycorrhizal fungi, semiarid ecosystem.

Nursery inoculation of native woody seedlings with simple pot-cultures of relict populations of indigenous arbuscular mycorrhizal fungi can aid re-vegetation of desertified land

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Symbiotic arbuscular mycorrhizal fungi (AMF) can enhance nutrient and water uptake by plants and increase their ability to withstand environmental stresses. Vegetation loss, soil degradation and desertification impoverish the soil's AMF population. Indigenous AMF populations, adapted to local soil and edaphic conditions, can be multiplied by simple trap culture. and used to inoculate seedlings. We are outplanting AMF inoculated seedlings as part of a revegetation project in Almería province, SE Spain, using the native legumes *Retama sphaerocarpa* and *Anthyllis cytisoides.* We have parallel community-based trials in the arid central zone of Tanzania and in the Sahel region of Burkina Faso using AMF to enhance establishment and growth of trees of ecological and economic value. The Tanzanian pilot trial with *Tamarindus indica* and *Annona muricata* showed improvements in both growth and survival with AMF inoculation. In our first Almería trial *R. sphaerocarpa* and *A. cytisoides* were grown in a nursery for 6 months spanning a harsh winter. *A. cytisoides* seedlings only survived if inoculated with AMF; both inoculated and uninoculated *R. sphaerocarpa* seedlings survived, and were then outplanted in May 2004. At 16 months old, inoculated and uninoculated *R. sphaerocarpa* grown in unsterilised soil are larger than uninoculated plants grown in sterilised soil. Our current trials involve the Moroccan tree *Argania spinosa*, a rapid taprooter suitable for reforestation in Spain, and *A. cytisoides* grown together with a grass species believed to be symbiotic with it in natural ecosystems.

Keywords: arbuscular mycorrhiza, revegetation, semi-arid, inoculation.

Understanding seedling mortality in reforestation with Mediterranean oaks: environmental heterogeneity *vs.* plant morphology and physiology

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Despite extensive reforestation activities in degraded Mediterranean lands, our knowledge of the processes affecting their success is still limited. We have carried out a reforestation with phenotypically contrasting seedlings of two evergreen oaks (*Quercus ilex* and *Q. coccifera*) in a severely burnt shrubland patch in Enguera (38º 58' N, 0º 40' W, Valencia, Spain). The phenotypic variability was experimentally maximised by growing plants under different water and nutrient regimes (three levels of each factor: low, intermediate and high) in a nursery (Viveros San Fernando, Madrid, Spain). Two thousand plants were transplanted in the winter 2002/03 and their performance was followed during the spring 2003, winter 2004 and winter 2005, to determine transplant shock, which caused 9% mortality, and mid and long term survival. Seedling mortality after 2.5 years was high (78%) and it was primarily induced by the first summer in the field, which was one of the hottest and driest summer over the last one hundred years. While the spatial pattern of the planted seedlings was random, the pattern of mortality was significantly clustered, indicating an important influence of local habitat heterogeneity on survival. However, the morphological and physiological features of the plants at the time of leaving the nursery had also a significant influence on the probability of survival. Initial survival was significantly influenced by plant size, while long term survival was not affected by morphological characteristics but by physiological features (i.e. chlorophyll content and photochemical efficiency).

Keywords: reforestation, Mediterranean oaks, seedling survival, phenotypic variability, environmental heterogeneity.

The evaluation of veld condition after the eradication of *Rhigozum trichotomum* in the southern Kalahari, South Africa

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Extreme cases of rangeland degradation are clearly visible in the southern Kalahari region, South Africa. Dunes become completely bare with mobile sand, while the interdune areas are invaded by the shrub *Rhigozum trichotomum* (Three Thorn). These plants increase to very high densities where the grass layer is removed by grazing, and are capable of suppressing the grass layer once established. *R. trichotomum* productivity is low and the shrub contributes very little to the grazing capacity. In this study four different *R. trichotomum* encroached sites in the southern Kalahari were treated with herbicide over a period of ten years (Molopo 200 GG). After treatment the areas were not totally excluded from grazing, but grazing was controlled through a rotational grazing system. Linepoint surveys were conducted in each of the treated areas to determine the species composition of the different sites. Results from the linepoint surveys show that the degraded area is visibly recovering following only one year after the control of *R. trichotomum* shrubs. Two years after the application of the herbicide the annual grass species, *Schmidtia kalihariensis* (Sour Grass), shows a high abundance in the treated area, while the climax perennials, *Stipagrostis ciliate* (Tall Bushman Grass), *S. obtusa* (Short Bushman Grass) and *Centropodia glauca* (Gha Grass) occurs in the five years and ten years after treatment sites. The occurrence as well as the distribution of these climax species in the five and ten year sites increases the grazing capacity in the study area from 257 ha/LSU to 32 ha/LSU. From the results of this study it is clear that after the eradication of the invasive *R. trichotomum* shrubs and with good management strategies natural grazing areas in the Kalahari can be restored to such an extent that it can be utilized by the land user within a period of five years.

Keywords: Kalahari Desert, *Rhigozum trichotomum*, Bush encroachment, Grazing capacity.

Survival plan for woodland & nature in the Netherlands

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In 1989 in the Netherlands a Survival Plan for Woodland and Nature was drawn up to bridge the timelaps needed for the Dutch environmental policy to become fully effective. The survival plan was designed as a temporal solution until 2010. Subsidy (currently 10 million euro annually) is granted to the owners of woodland and natural sites for the execution of restorative measures aiming at the reduction of the effects of acidification, eutrophication and desiccation. Part of the budget is used for research and monitor-

ing of results. Groups of experts including representatives of management, research and policy making are active per ecosystem type. This form of co-operation has proven to be very effective. It enables researchers to recognise actual field problems more quickly and provides field staff with easy access to the most recent data and good contacts for advice. This ensures constant innovation of knowledge and leads to optimisation of restoration practice. In the past 15 years the Survival Plan has proven its worth. Dozens of natural sites have been restored and over one hundred rare and sometimes even long-lost species have returned to the treated sites. In this communication to the congress an overview of the results will be presented. Furthermore advantages and limitations of the network approach towards knowledge development will be indicated.

Keywords: survival plan, woodland, natural sites, Netherlands.

Biosolids compost effects on restoration of a burned *Nothofagus pumilio* forest in Patagonia, Argentina

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Wildfires constitute the most important disturbance in Patagonian forests leading to severe losses of soil fertility and native species. The aim was to study biosolids compost application to recover a burned *Nothofagus pumilio* forest, by promoting the establishment of "fertility islands" which would facilitate regeneration. The essay was carried out in a *N. pumilio* forest burned in 1996, (Nahuel Huapi National Park). In microsites with or without litter accumulation, we studied: (i) soil characteristics, seed bank and post-fire vegetation and ii) effects of biosolids compost applications on soil and vegetation. Results showed that: I) soil recovered poorly, ii) litter improved soil fertility, constituted an important reservoir of permanent seed bank but, it favoured neither plant diversity nor regeneration at field conditions, iii) seed bank and vegetation cover was dominated by exotic species and iv) compost application improved soil fertility, but did not contribute to vegetation recovery. We concluded that burned *N. pumilio* forest had low post-disturbance resilience. The low post-fire regeneration was probably due to a poor seed bank and high fire intensity, which affected native species sprouting more than soil fertility. Colonization by exotic species may be a solution to avoid further deterioration. These results confirm the need to apply restoration strategies that promote the revegetation in burned *N. pumilio* forests.

Keywords: post-fire, soil fertility, seed bank, vegetation forest, biosolids compost.

Study of radium and radon distrution in a tail deposit of Kara-Balty industrial complex (the Kyrgyz Republic)

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In institute of Physics of National Academy of Sciences of the Kyrgyz Republic and in Russian Federal Nuclear Center – All Russia Research Institute of Technical Physics of academician E.I. Zababakhin (RFNC – VNIITF) the ISTC project # Kr-715 “Study of main ecological indicators of the territories adjacent to uranium production in conditions of its partial conversion” is carried out. Project objectives: 1) Obtaining mathematical models of wind erosion physical processes in territory of the tail deposit and transport of pollutions with underground waters taking into account the uranium sorption migration in multi-components solutions through the tail deposit’s foundation. 2) WEB-node development in INTERNET with provision of information on ecological situation in a district of Kara-Balty industrial complex. 3) Development of recommendations package of KBMC territories utilization under enterprises not connected with weapon industries. This information is devoted to the following project tasks: (1) Investigation of main toxic ingredients concentration in the matter of the tail deposit depending on depth of its location. (2) Mathematical modeling of wind erosion physical processes on tail deposit’s surface. (3) Creation of geo-migration model of a process of contamination transport with underground waters taking into account sorption model of uranium migration in multi-component solutions through the tail deposit foundation. (4) Investigation of uranium content in surface layer of troposphere over the tail deposit, sanitary-protective and inhabited territories. To study main toxic ingredients variation in tail deposit’s matter depending on depth of its location, the boreholes were drilled trough all tailings’ depth (up to 27 m). Interval sampling was every 1.5 m. The concentrations of heavy metals were defined on spectral installations; radium and other radioactive elements were measured on scintillation gamma-spectrometer. The outcomes obtained at implementation of the ISTC projects Kr-072 and Kr-715 were taken for mathematical modelling. During investigation of radon distribution in surface layer of troposphere both industrial equipment and a field instrument developed by us, al-

lowing defining directly a radon concentration in air, were used. The sensitivity of the developed instrument is 20 Bq/m^3. Radon admissible concentration in air is 200 Bq/m^3, i.e. it exceeds the instrument's sensitivity in 10 times and can be measured with inaccuracy of around 3%. Ecological situation of investigated territories as well as the project progressing can be found on the site: www.vniitf.ru/Karabalta.

Keywords: program, mathematical modeling, erosion physical processes.

Importance of hHydrochory as an important factor for species composition in the restoration of plant diversity in alluvial meadows

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Floods could play an important role in seed dispersal. Seed movement by floods in the Meuse valley in France was analysed in three grassland communities arranged along a wetness gradient from moist to wet. We measured dispersal both in the laboratory and *in situ*. In the laboratory we measured seed buoyancy for 24 characteristic species of flood meadows. In the field we measured seed transport during the flood events in floating traps. We also measured the amount of seeds deposited by floods by traps at the surface. Measurements of seed buoyancy showed that all 24 species could be considered as long-floating species although differences appeared between standing and moving water. Trapped seeds originated from meadow, arable land, river bank and woodland communities. The number of meadow species that were found in the floating traps was large but the number of seeds per species was low. In the case of the ground traps more species were found and the number of seeds per species was larger Both species richness and the number of trapped seeds did not differ among the three communities. These experiments confirmed the ability of meadow species to be dispersed by floods and to colonise meadows. Nevertheless, meadow species were scarcely present in the traps and this dispersal vector therefore seems to be hazardous.

Keywords: alluvial meadows, floodplain, hydrochory, wetness gradient, seed buoyancy, seed dispersal.

Early sucessional trajectories and regeneration rate in a large dry tropic landslide

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Natural recovery was studied in a large dry tropic landslide during the first four years after disturbance. We aimed to verify the existence of clearly differentiated early successional trajectories resulting from the effects of abiotic heterogeneity and small human disturbances. Data consisting on number, cover, density and mean height of species, and several abiotic and biotic characteristics were obtained from 28 permanent plots that reflect most of the environmental variation on the landslide. Changes in specific composition, richness and biomass were studied using DCA analyses, time series, and three complementary indices of succession rate. Results revealed marked early successional trajectories differing between the specific parts of the landslide. Stable and high productivity zones recover fast. In only two years they were occupied by a high-biomass community dominated by *Muntingia calabura*, a fast-growing pioneer tree. After the third year, individuals of shade tolerant species as *Heliocarpus appendiculatus*, *Maclura tinctorea* and *Enterolobium cyclocarpum* appeared in some near-to-landslide-edge areas, suggesting convergence towards adjacent forests. Fire intensely deflected successional trajectories in stable and medium productivity zones at during the third year by encouraging the dominance of two species of the genus *Desmodium*. Low productivity areas showed a later and slower recovery. Due to the initial paucity of vegetation, turnover rates were high when the first colonizers appeared. Richness was still increasing at the fourth year with the expansion of *Verbesina turbacensis* and *Wigandia urens*. Our results strongly support current ideas about the importance of abiotic site factors and stochastic events in determining natural recovery of disturbed areas and could provide a basis for further discussion about early successional trends in dry tropic landslides.

Keywords: Landslide, early succession, trajectories, succession rate, convergence, disturbances.

Restoration of an old pit in Aguilar de Campoo (Palencia, Spain)

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Restoration of this inactive exploitation aims at integrating the pit in landscape, controlling erosion and runoff, and stabilizing soil. The latter is very important because of the nearness of Madrid-Santander railway. So that, partial filling with a stable slope, drainage structures to runoff control and revegetation to erosion protection and landscape restoration are established in this project. A very exhaustive analysis of landscape has been studied: visible area, visual quality and landscape fragility. Design for topographic remodelling stability has been made by Morgenstern & Bishop and Hoek & Bray methods. Top soil (vegetable earth) stability also has been studied by Infinite Slope Method. Design for erosion control is made using Universal Soil Loss Equation; and drainage structures are designed by Modified Rational Method proposed by Temez for Spain. Hydroseeding in two phases is defined for better revegetation with *Festuca, Medicago, Trifolium, Genista, Thymus, Lavandula*, etc. Plantation of several native trees (*Quercus faginea, Pinus sylvestris*) and shrubs (*Crataegus monogyna, Rosa canina, Prunus spinosa*) is projected. Landscaping effects will not happen immediately; but projected activities are of benefit to the area, especially with terrain remodelation and established vegetation. Both actions will improve landscape and will integrate the old exploitation hole around. This project is promoted by Castilla-León Government for soon execution, and budget raises to 392 911,51.

Keywords: Mines, pit restoration, landscaping.

The N/P ratio in wetland vegetations: a seasonal and functional relationship

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Recognizing the nature of nutrient limitation can help restoring and managing valuable plant communities. The 'N/P ratio^{ss}', measured at the height of the growing season, is compared with a 'seasonal N/P ratio' assessed by correlations between phosphorus and nitrogen of aboveground living biomass. A 'functional N/P ratio' is determined as the correlation between N and P for both above and below ground vegetation compartments. Data were collected in 15 wetland vegetations across the Flanders (Belgium) on 4 occasions during 1 year with 4 replicas per site. The N/P ratio^{ss} was for 11 sites significant different with the seasonal N/P ratio of aboveground green biomass. This result suggests that a singular assessment of the N/P ratio may not be sufficient to assess the nature of nutrient limitation on a vegetation level. The functional N/P ratio showed significant correlations for all sites except 1 (R^2: 0.10), suggesting that incorporation of root N and P content is useful. R^2 parameters varied between 0.29 and 0.95, indicating that some sites do have a homogeneous and strong interrelation between nitrogen and phosphorus. We conclude that the seasonal and functional N/P ratio can differ with the N/P ratio^{ss} and that this may have consequences for evaluating nutrient flows in the landscape.

Keywords: N/P ratio, wetland vegetation, seasonal N/P ratio, functional N/P ratio.

Restoration actions to combat desertification. A demonstration project in Albatera (Alicante, Spain)

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The Albatera pilot area is a 25 ha catchment located in Alicante province, Southeast Spain, one of the most desertification affected areas in Europe. Land degradation has been driven by the combined effect of past exploitation and management and harsh environmental conditions such as scarce and highly variable precipitation and soils prone to erosion. The demonstration project implemented in Albatera was designed as a set of ecologically sound, multi-purpose measures adapted to the complex problem addressed. The main objectives of the restoration program were: 1) to repair ecosystem functioning by creating fully functional vegetation patches that contribute to the conservation of resources, 2) to increase ecosystem diversity and resilience, and 3) to prevent further landscape degradation and off-site damage. The restoration strategy included a wide set of specific actions and species choices to match the diversity of habitats, landscape functional units, and natural patterns in the target area; the plantation of evergreen trees and shrubs that can recover quickly after disturbances; the improvement of seedling quality and plantation success by exploiting recent research results; the enhancement of spontaneous plant growth by applying organic amendments; and site preparation techniques aimed at maximizing water

harvesting. Despite the extreme drought occurred during the first post-plantation year, the monitoring of the restored area showed promising results, with average survival rates in the various land units ranging from 45% to 70%. Under the limiting conditions prevailing in very degraded lands such as the target pilot area, the best-technology actions applied are expected to yield a positive cost-benefit balance.

Keywords: Demonstration project, ecological restoration, landscape functional units, restoration monitoring, semiarid.

Influence of fertilization and *Rhizobium* inoculation in the nursery on the transplanting performance in different provenances of the Mediterranean legume shrub *Retama sphaerocarpa*

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We analysed the outplanting survival and growth of several provenances of *Retama sphaerocarpa* that were raised in the nursery under contrasted fertilisation rates. Similarly, we addressed if nodulation with *Rhizobium* in the nursery enhances transplanting performance. Seeds were recollected from five localities of the centre, northeast and southeast of Spain and sown in containers filled with peat. Plants were raised with two amounts of fertiliser: high (each plant received 100, 30 and 2 mg of N, P y K) and low (each plant received 10, 5 and 2 mg of N, P y K). Half of the low-fertilised plants in one of the provenances were inoculated with a strain of *Rhizobium*. After nursery cultivation, seedlings were transplanted at the beginning of the winter in an abandoned crop field in the centre of Spain. Provenances did not differ in transplanting performance. Fertilisation increased seedling survival and growth two years after transplanting. Survival of high- and low-fertilised plants was 83% and 59%, respectively, and high-fertilised seedlings had a 3.4 fold higher growth than low-fertilised plants. No significant difference in performance was observed between nodulated and non-nodulated plants. High-fertilised non-nodulated plants had higher survival and growth than low-fertilised nodulated plants.

Keywords: afforestation, plant quality, survival, inoculation.

Influence of nursery cultivation method on the transplanting performance of a Mediterranean mountain juniper (*Juniperus thurifera*)

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The objective of this study was to identify the fertilization regime and container type that maximizes the transplanting performance of *Juniperus thurifera*, a Mediterranean mountain- juniper. Plants were grown in containers of 200 and 300 ml and with three amounts of N: 30 (low), 75 (moderate) and 150 (high) mg N plant^{-1} year^{-1}. Plant density in both container was 418 plants m^{-2}. Amount of P and K for each N fertilisation level were 40 and 74 mg plant^{-1} year^{-1}. *Juniperus thurifera* seedlings have to be grown for two years to achieve a minimum size for their use in forestation, even if seedlings are raised with high amount of N. N fertilisation affected positively plant size and new root growth capacity. Container size had a marginal effect on plant morphology. One year after field transplanting, plant growth was affected positively by fertilisation in the nursery. High and moderate fertilised plants had 360 and 340% higher stem volume increase than low fertilised seedlings. Growth differences among high and moderate fertilised plants were not significant. During the first summer after transplanting, high fertilised seedlings also had higher water potential than moderate and low fertilised seedlings. Container size did not influence transplanting performance. Mortality was very low and no differences existed among nursery treatments. We recommend to cultivate *Juniperus thurifera* with at least 75 mg N year^{-1} and in containers of 200 ml.

Keywords: plant quality, afforestation, fertilisation, container, water potential.

A theoretical historical reference for Dutch heathland fauna: a tool for the identification of important bottle-necks

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Heathlands are semi-natural landscapes of dwarf shrub vegetation (Calluneta). These have been created through small scaled, but intensive anthropogenic use (wood cutting, sheep grazing, sod cutting, burning). Being most intensive near settlements and getting more extensive further away, this use gave rise to a heterogeneous mosaic of different habitat patches and provided a home to many characteristic species. Habitat destruction, years of neglect, increased N-deposition and soil-acidification have all contributed to the degradation of Dutch heathlands. Nowadays, several management practices are being used in order to restore and preserve the Dutch heathlands. Although this management intends to restore the whole ecosystem and many plant species have returned (especially Calluna and Erica), characteristic fauna species often do not benefit. To improve heathland restoration management, we need to know how and why these species could occur in the historic situation and what has changed in the present situation, causing bottlenecks within their life cycle nowadays. Therefore we made an analysis of the historical land use of heathlands. From this analysis we derived the biotic and abiotic characteristics along (theoretical) gradients in management intensity and management practices. For characteristic Lepidoptera and Orthoptera species we determined the life-history strategies in order to identify suitable habitats on this theoretical heath gradient. By contrasting this theoretical historical gradient with the present situation we could identify existing bottle-necks for characteristic fauna species. Additionally, this tool identifies important knowledge gaps in species- and/or landscape-ecology that need to be filled in order to successfully design sound management of heathlands.

Keywords: Heathland management, Lepidoptera, Orthoptera, life-history, historical land use.

Differences in centipede (Chilopoda) assemblages on reclaimed and non-reclaimed spoil heaps

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Changes of community structure epigeic activity, and density of centipedes were studied in afforested reclaimed spoil heaps (1993-1998) and in non-reclaimed colliery spoil heaps with spontaneous plant succession (1999-2005), all located in the Sokolov coal mining district (Czech Republic). Long-term pitfall trapping and soil sampling were used on four reclaimed and four non-reclaimed plots differing in age of succession. The pioneer species *Lamyctes emarginatus* occured in both reclaimed and non-reclaimed young plots, whereas *Lithobius melanops* was found in non-reclaimed plots only. During the succession epigeic activity of these species decreased because of increasing activity of *Lithobius Forficatus* and *Lithobius microps*. In young successional stages the centipedes occurred in high numbers of individuals but with very poor species spectrum (usually 1-2 species), while in later successional stages the number of individuals decreased and the species spectrum increased up to 3-5 and 6-8 species in reclaimed and in non-reclaimed plots, respectively. Poor species spectrum of centipedes in reclaimed plots supports the importance of plots with spontaneous succession for restoration practices used in the extended areas of colliery spoil heaps.

Keywords: centipedes, spoil heaps, succession, restoration.

Effects of shading on germination and early growth of *Cyclobalanopsis glauca* (Fagaceae) in subtropical abandoned fields: Implications for vegetation restoration

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The restoration of abandoned agricultural lands back to their native vegetation is urgent and challenging work. In response to a new initiative in China started in 2002, the National Engineering Program on Converting Abandoned Agriculture Land to Forest Stands, this study was undertaken to seek novel approaches for accelerating forest restoration efforts. We tested the hypotheses that the climax species, *Cyclobalanopsis glauca*, is not able to establish and grow on abandoned lands but that shading can accelerate the early growth of *C. glauca* seedlings in abandoned fields. We carried out a 2-year field experiment on the germination and early growth of *C. glauca* in subtropical abandoned fields under three

different shade treatments (100%, 40% and 22% PAR) and compared their growth and biomass to 2-year old *C. glauca* seedlings growing in a natural forest environment. Our results showed that: 1) both shade treatments enhanced the establishment and early growth of *C. glauca* seedlings as compared to full sunlight, and that growth and survivorship was greatest in the 22% PAR treatment; and 2) the growth and biomass of *C. glauca* seedlings on abandoned fields were equal to or greater than the growth and biomass of seedlings growing in nearby forests. This study supported the viewpoint that consideration of a species shade tolerance is a critical factor when developing restoration management strategies. The restoration or succession of abandoned fields in Dujiangyan, a subtropical region in SW China, can be accelerated by shading *C. glauca* seedlings at levels of 22% PAR.

Keywords: early establishment, evergreen broad-leaved forest, native species, restoration ecology, shade tolerance, Southwest China.

Root of pioneer trees in the lower sub-tropical area at Dinghu Mountain, Guangdong, China

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In the subtropical area, South China, representative pioneer tree root systems were examined with regard to their structure, underground stratification and biomass distribution, also the maximum rooting depths, maximum lateral root spreads were measured. Excavation of skeleton roots and observation of fine roots included seven species belong to the Euphorbiaceae, Theaceae, Melastomataceae, Lauraceae, Fagaceae. The results showed: 1 the pioneer tree roots in the first stage in natural succession had two type, one is characterized by the taproot with bulky plagiotropic branches, such as Schima superba, which root skeleton is situated radially in the upper layer of the soil profile, also with one or two deep tap root. The other is characterized by the flat root system with several tabular roots, such as Castanopsis chinensis, a few plagiotropic skeleton roots dominate the system. Root of the late pioneer mesophilous tree species is characterized by one obvious taproot and tactic braches roots up and down, such as Cryptocarya concinna; Cryptocarya chinensis and Aporosa Yunnanensis. The pioneer species of shrub root system is characterized by the heart root type featured by both horizontally and transversally growing braches, such as *Blastus cochinchensis*, *Psychotria rubra*, with the general fine root concentration in the upper soil horizon. So different root shapes varied in different species in succession. Coarse skeleton roots differed in the shape and position of the plagiotropic branches and positively geotropic taproots. 2 Root of particular species varied in the external features of their color and periderm and structure of freshly cut slash. 3 In a set of successional stages the amount of tree roots linearly increased with the age of growth. In monsoon evergreen broad-leaved forest, the total tree root biomass amounted to 115.70 ton/ha, Needle and broad-leaved mixed forest dominated by coniferous 50.61 ton/ hm^2, Broad-and needle-leaved mixed forest dominated by broad-leaved heliophytes 64.20 ton/hm^2, thus being comparable to the underground biomass observed in similar tropical forests. However, fine roots below 2 mm in diameter shared 60-88% of all roots in the upper 20 cm layer of all sample plots.

Keywords: pioneer tree, tree roots, lower subtropical forest, Dinghu Mountain, China.

Dead trees effects on biodiversity of Caspian Beech Forests North of Iran, Nooshahr

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Just because a tree stop living doesn't mean it stops giving to environment around it. On the contrary a dead tree has a long and productive after life a standing dead tree, known as a Snag is a miniature ecosystem bustling with the activities of thousands of living things. Tree mortality (Snag & Downed log creation) naturally occurs in forests Dead trees make alive habitat and in addition Biodiversity in forest, and help to settlement of regeneration. This study was carried out in Northern Iran, in 50 hectares of virgin forest of Kheiroudkenar with measurement of all dead and alive trees. The results indicated that from the volume of 349.22 m^3/hac formed by stand, 16.52 m^3/hac was belong to dead trees. alive stand volume is consisted of 49% *Fagus orientalis*, 21% *Carpinus betulus*, 15% Alnus sp, 11% Acer sp, 3% *Quercus castaneifolia* and 1% other species and dead trees volume include 42% *Fagus orientalis*, 39% *Carpinus betulus*, 6% Alnus sp, 11% Acer sp, 11% *Quercus castaneifolia* and 1% other species, 26.93% of total volume of dead trees was Snags and 73.07% was Downed logs. Comparing of these percents of alive and dead trees volume, shows that *Fagus orientalis* is in balance position in this stand, *Carpinus betulus* is

decrease, *Ulmus carpinus* and *Quercus castaneifolia* are in extinction from this stand, but Acer sp and Alnus sp are increasing. Dead trees open gap in crown of stand and reserve moisture and give nutrition materials to soil, so influence by have several effects to regeneration. k-square test shows that there is no significant differences (at 5% confidence limits) among snags and downed logs to settle regeneration, and there is a significant difference between the dead trees with various degrees of decay. Number population of insects indicated that the family of insects is known as Cerambycidae had the highest population in compare to other families, and *Q. castaneifolia* and *F. orientalis* had high activity of insects and funguses respectively on their dead trees. Managing of dead trees can help to improve biodiversity in forests, and we should keep them in future forest programs.

Keywords: Northern Iran, *Fagus orientales, carpinus betulus, quercus casteneifolia.*

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