# European Platform for Biodiversity Research Strategy

**Bioplatform meeting under the Spanish EU Presidency**

Communications to the electronic conference

## Scientific responses to threats in Mediterranean ecosystems: conservation, mitigation and restoration

15th - 28th April 2002

The European Platform for Biodiversity Research Strategy (EPBRS), the BIOPLATFORM Thematic Network and the Spanish Biodiversity Platform held an electronic conference on "Scientific responses to threats in Mediterranean ecosystems: conservation, mitigation and restoration" from 15th to 28th April 2002. The electronic conference developed within the framework of the BioPlatform project (http://www.bioplatform.info), a thematic network of scientists and policy-makers who aim at improving the effectiveness and relevance of biodiversity research in Europe. The e-conference preceded the EPBRS meeting in Almeria, Spain on 11-13 May with the general theme of European heritage under threat: Biodiversity in Mediterranean ecosystems. The EPBRS aims to enhance communication between field practitioners and scientists working in conservation biology, and in this conference we look for a closer interaction between people involved in biodiversity conservation in general and in Mediterranean ecosystems in particular. One of our goals is to develop strategies to overcome scientific and socio-economic problems so that conservation programmes are more effective. there are two parallel sessions, dedicated to counterbalance threats to conservation of biodiversity in the Mediterranean ecosystems. The first session, chaired by Helena Freitas, University of Coimbra, Portugal focused on "Protective measures and mitigation of threats" and aims at identifying species and habitats in need of protection, the establishment of protection measures and implementation of conservation strategies. The second session was chaired by José M. Rey-Benayas, University of Alcalá, Spain and focused on "Restoration Ecology." It aimed to discuss ways of recovering and regaining functionality of degraded ecosystems. Using Mediterranean ecosystems as a case-study, in the electronic conference we wanted to describe and characterise problems and suggest solutions for biodiversity conservation throughout Europe. Thus specific and foreseen threats, potential solutions, practical tools, past experiences, and management suggestions were treated.

## Steering Committee

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# Contributions

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## **Session 2**: Restoration Ecology

# Session 1: Protective measures and mitigation of threats

**Introduction message**

Helena Freitas, Chairwoman - Universidade de Coimbra, Portugal

Introduction

1) Conservation problems in Mediterranean Ecosystems: a global overview

The Mediterranean region is of high value to global biodiversity due to its wealth of species, high rate of endemism, long history, and tolerance to several kinds of disturbances. However, the continuous environmental pressure maintained by humans in the Mediterranean throughout history is now an obvious component of all Mediterranean ecosystems. The size and distribution of the human population over the near future will be a crucial factor in determining the loss of biodiversity in the Mediterranean basin. Over the last few decades, major socio-economic changes have increased the negative impact of such human activity, mainly along the coasts. In this respect, the Mediterranean islands are especially vulnerable. During the last 50 years, there have been differences in the development of human populations in north and south Mediterranean countries. The population in the Maghreb has increased 300%, leading to the overexploitation of rangelands and to desertification, while in northern countries it increased only 30%. However, the relocation of people to the coastal border in northern Mediterranean countries and the intensification of the agriculture are leading to increased land degradation on both shores of the Mediterranean. On the other hand, land abandonment inland is in some cases allowing soils and vegetation to recover. In many cases, however, soils are so exhausted and degraded that their recovery is no longer possible in the near future. Insufficient information on species distribution prevents any objective assessment of the current situation on the Mediterranean basin. It is also difficult to plan conservation actions for species and habitats, as only very limited information on ecology, species biology or habitats exists. In addition, many taxonomic groups are still insufficiently documented, making it difficult to assess their conservation status. The present network of protected areas preserves only a limited proportion of biodiversity at risk, and there is a scant scope for bringing many more wildlands under protection within the foreseeable future because of rising human numbers and their demands on natural environments. Protected areas are insufficient in number, and are often not, or only poorly, managed. Moreover, most protected areas are proving unable to preserve more than part of their biodiversity in the long run.

2) The role of the European Strategy for Biodiversity Conservation

Europe has a high diversity of species and habitats. It is heavily populated and industrialised and this imposes an increasing pressure on our natural heritage. More than two thirds of the existing habitat types are considered endangered and a high percentage of species in Europe are at risk of extinction, frequently as a result of human activities The European conservation challenge is the implementation of the biodiversity conservation strategy, essentially supported by two Directives: Birds and Habitats. Together, these two Directives set up the Natura 2000 ecological network. The Habitats Directive, on the conservation of natural habitats and of wild fauna and flora, was designed in 1992 to

address the special challenges faced by Europe's habitats and species. One essential measure is the creation of a network of Sites of Community Importance. This network - Natura 2000 - also includes Special Protection Areas (SPAs) designated under the Birds Directive. The Habitats Directive requires strict procedures that must be observed when considering the potential impact of economic development on Natura 2000 sites (article 6), and oblige European member states to guarantee that they are restored to and/or maintained at "favourable conservation status". The Habitats Directive also compels member states to improve the "ecological coherence" of the Natura 2000 network by ensuring that their land use planning policies maintain key features outside protected areas, especially those that function as corridors or stepping stones between sites (article 10). It establishes a system of protection for fauna and flora species outside protected areas (articles 12-16) and promotes sustainable management of the countryside by recognising the role of certain economic, social and cultural activities in biodiversity management. The Directive is therefore considered as a critical tool to prevent the loss of biodiversity in Europe. Although designed to protect the European common heritage, the Natura 2000 network does not provide mechanisms either for maintaining existing land management, which may be economically unworkable without support, or for achieving changes, some of which may involve considerable costs to land owners and farmers. In many regions, the Natura 2000 network is viewed as a serious constraint to local development. The only way to overcome this difficulty is to develop special development schemes compatible with natural values as the Natura 2000 sites are considered European common heritage. These areas from which a high percentage are located in the Mediterranean region, should become models of implementation of sustainable development practices.

3) The importance of agri-environmental measures

With respect to European agricultural policies, the so-called agri-enviromental measures (Directive 2078/92/EEC) for biodiversity conservation issues have been integrated into the Common Agriculture Policy (CAP) after the reform of the CAP in 1992. Agri-environment measures offer farmers voluntary, multi-annual contracts where they are paid for delivering environmental goods and services which go beyond the 'reference level' of good agricultural practice in the country or region concerned. Especially in marginal and less favoured areas of the European countries, very common in the Mediterranean region, where productivity is often low and not competitive, these specific measures are accepted as an option for the upkeep of abandoned land and to sustain less productive agricultural land. In many of these areas, the strategy is to promote biodiversity conservation together with extensive agriculture. Information and management plans for these areas are crucial and farmers demand help because, for example, they need to know the acceptable intensity of grazing for specific conditions of soil erosion or plant productivity. Better information on the consequences of the loss of biodiversity in terms of ecosystem functioning, or the gains of sustainable management and restoration of natural ecosystems, is essential for the development and effective implementation of European conservation policies. The need to provide integrated scientific and socio-economic information to develop the necessary tools for conserving biodiversity in less favoured areas is also obvious.

4) Conclusions

Appropriate conservation of Mediterranean biodiversity and mitigation measures should aim:

1. To assess the conservation status of major biodiversity groups of the Mediterranean region;
2. To improve and integrate current knowledge on species, habitats, threats, protected areas and people working in conservation;
3. To identify conservation priorities and develop appropriate strategies and tools;
4. To settle and support implementation of conservation Action Programs for species and habitats;
5. To make tools specific to species and habitat conservation available to managers;
6. To establish a biodiversity monitoring network;
7. To improve and disseminate knowledge and information;
8. To increase awareness of decision-makers and the public. At regular intervals I will prepare a summary of the discussion. I wish you all a profitable discussion.

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**Reply to Introduction message from the chairwoman**

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Thanks to Helena Freitas, Jose Rey-Benayas and Guy Beaufoy for their introductions. In regards of Helena's first conclusions, I would like to submit the recommendations I drafted as a contribution to the Transboundary Diagnostic Analysis under preparation by MAP. I tried to be as much specific as possible, referring to the existing programmes on the Mediterranean. Then, more on the research side, I tried to look at how to develop an ecosystem approach as recommended by the Convention on Biological Diversity:

-- Outlook and recommendations --

Pollution effects, sometimes exacerbated by climate change factors, are only one of the problems threatening the viability of the Mediterranean’s an ecosystem. The alteration and destruction of marine and coastal habitats through improper development practices and poor management are also very significant problems. All around the Mediterranean basin, coastal urbanisation is interrelated with biodiversity losses, stable increase of water demand, as well as of wastes and thus pollution. Wetland losses and environment degradation have imposed a serious threat to many aquatic species. The creation of marine protected areas for conservation purposes is often not sufficient as an impact-limitation measure, since many of the impacts derive from pressures that are not necessarily locally originated. The protection of species and habitats in the Mediterranean should note based on a number of separate measures directed to the protection of certain species on the one hand and certain habitats on the other. The protection of species and habitats needs an integrated ecosystem approach, based on the conviction that an ecological network should be protected and restored when and where necessary.

## Measures

With reference to what have been said before, the following is recommended: In the context of the protection of species and habitats, pollution reduction continues to deserve high priority through national and regional planning going from the reduction of contaminants sources, better knowledge of their fluxes and inputs into the sea, and well coordinated coastal monitoring system allowing a better understanding of their dynamic and thus location through time and within space. In the further development of a strategy to protect species and habitats, the following policy options should be considered: · To implement with high priority the provisions of the Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean, i.e. the identification of marine sites (including coastal, estuarine, and open seas area) of national or regional importance, in accordance with the common criteria adopted. · To identify an ecological network of habitats in the Mediterranean which could serve as the focal point for the protection of selected species. Seagrass beds could be one of the first selected habitat for such a networking, provided their large spreading in the entire Mediterranean basin and their crucial ecological role in coastal waters. For these qualities but also because of their vulnerability, seagrass beds have been chosen as the main sustainable development indicator for coastal waters biological quality in the Mediterranean. · To use the elements (species and habitats) of this network, and the identified marine sites of national or regional importance, for the further elaboration of ecological objectives for the Mediterranean. · To develop special protection regimes for these habitats (including coastal, estuarine, and open sea areas), inter alias, including measures to reduce particular sea uses and to establish water quality objectives. · From the definition of ecological and water quality objectives, to develop a common set of meaningful indicators of success, i.e. to demonstrate the benefits and effectiveness of Specially Protected Areas and Biological Diversity in the Mediterranean (SPAMI). These indicators should be based on a compilation of the biological, economic, socio-cultural, and process variables that would be identified and defined by local stakeholders and managers as directly influencing Specially Protected Areas impact. · From an active and networked application of these indicators, could unfold an effective "Good Practice Guide" which would facilitate the integration and application of these indicators at the early stages of Specially Protected Areas management strategy. · To implement the different Action Plans adopted for the protection and/or recovery of selected species.

## Research

Besides inventories of species like the current one carried out by CIES on allochthonous species in the Mediterranean, there is an urgent need of inventories of habitats. More particularly, since it has been defined as a key sustainable development indicator, there is an urgent need to make a thorough inventory of the state of seagrass beds all around the Mediterranean basin which, given the hugeness of the task, supposes the settling of a well-defined and coordinated mapping strategy based on a common methodology. Within an ecosystem, there are many hierarchical levels of organization that are linked to one another (i.e., nutrient cycling, trophic levels, water flow, etc.). To adequately ensure that the best management decisions are being made with the best available scientific data, changes in the functional processes of an ecosystem must be measured on the physical, biological, and chemical levels using various indicator parameters. For example, much attention should be paid to linking biodiversity issues to ecosystem level indicators such as NPP (Net Primary

Production). Similar to NPP, nutrient and carbon cycle models (e.g. the Thau lagoon, the Ionian Sea) are also in the early stages of development, especially for management purposes. Yet it seems clear that NPP estimates are an essential component of ecosystem management and that biodiversity by itself is an insufficient tool. To overcome this knowledge gap, greater attention should be placed on measuring NPP in ecosystems. Productive capacity will have to overcome its obvious public relations and comprehension disadvantage to biodiversity. How can sediments, seagrass leaf mass, and unseen nutrients be made as charismatic as dolphins or whales? This is certainly part of the education work of ecosystem management, i.e. the adoption of a systems perspective acknowledging the role of diversity as it relates to other factors that influence the system, including the human factors (uses). Following this approach of ecosystem management, monitoring should be considered crucial and for that there is a need for the development of long-term monitoring programmes at the national level, developing as much as possible standardized methods so as to allow the coordination of such programmes at the regional level when necessary. In that regard, increased attention should be devoted to the concept of eco-regions as proposed by recent studies like the World Wildlife Fund mentioned above (cf. Sensitive areas in the Mediterranean Sea), provided that higher-risk eco-regions will usually require more conservation attention (protected areas being only one of the tool) in order to maintain their biodiversity. In that sense, scientists and managers should take advantage of the methodology and results from international programmes applied in sub-regions (e.g. the Nile) like IGBP/LOICZ (Land Ocean Interactions in the Coastal Zone) which is devoted to the identification of coastal change and river catchment-based forcing of change by considering coastal geomorphology, coastal habitats/biodiversity, climatic conditions, people relationships (forcing drivers like demography), catchment size and seasonal runoff, land-use and cover. This effort of integration from a network of interdisciplinary scientific groups should be an excellent opportunity for "good science" input in the management process.

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**Agriculture and Biodiversity in the Mediterranean regions of the EU**

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Agriculture has an enormous influence on biodiversity in the Mediterranean regions of the EU. In particular, the processes of intensification and rationalisation of agriculture that have taken place over the past 30 years have lead to a wide range of impacts, including:

- Loss of biodiversity in farmed areas as a result of a simplification in cropping and grazing patterns, increased use of biocides, loss of ecological infrastructure (field boundaries, wet areas, patches of scrub, etc.);
- Destruction/alteration of natural and semi-natural habitats for expanding agriculture and for projects such as irrigation in dry regions and land consolidation in regions with minifundia structures;
- Degradation of freshwater habitats through over-abstraction of water for irrigation, dams and other projects, as well as pollution from agriculture and food-processing;
- Concentration of livestock grazing, leading to overgrazing of valued habitats (e.g. dehesas, steppelands, specific mountain pastures) and abandonment of extensively-grazed habitats, especially in less accessible uplands;
- Afforestation of valued habitats, especially scrub and grasslands; - Abandonment or intensification of traditional, low-input systems of high biodiversity (grazing and cropping systems);

- Habitat deterioration resulting from fires started by farmers to clear land, scrub, stubble;
- Illegal persecution (shooting, poisoning, trapping) of protected species on farmland that is also used for game shooting.

At the same time, it is recognised that certain types of agriculture in particular areas can be beneficial for biodiversity, through the maintenance of a specific habitats or combinations of habitats (e.g. extensively grazed grasslands, scrubland and wetlands, cultivated and grazed steppelands). In general terms, the Common Agricultural Policy (CAP) has helped to drive the damaging processes of intensification and rationalisation. This driving force has been felt through a combination of subsidy regimes which reward increased production and aids for structural changes (on individual farms as well as large-scale projects for irrigation, roads, etc.). However, it is clear that some sectors (arable cropping, olives, vines, sheep, cows) are more influenced by the CAP than others (horticulture, pigs, poultry), and also that the CAP is not the only influence: socio-economic and technological factors are of great importance. It is also apparent that the CAP has failed to mitigate the negative effects of intensification and rationalisation, by seeking to promote farming systems and practices that are more sensitive to the conservation of biodiversity. Some attempts have been made to address the needs of farming systems that are beneficial for biodiversity, through agri-environment incentives, but these schemes have been notably insufficient in Mediterranean countries, and have not reflected the scale and diversity of farming systems that are thought to be of value for the maintenance of biodiversity. Apart from the obvious lack of political importance given to agriculture and biodiversity, a significant obstacle to addressing these issues is the absence of concrete information on which to base new policy initiatives. In order to design appropriate policy measures for reducing the negative impacts and promoting the biodiversity benefits of agriculture, information is needed concerning: - The specific farming practices which influence biodiversity. - The landscape context in which different agricultural systems operate, as this is fundamental to overall biodiversity. - The socio-economic and policy forces (e.g. increased labour costs, rising incomes in other sectors, CAP subsidies and grants, changing technology) that can push farmers towards intensification, rationalisation, abandonment, or towards more ecologically-sustainable production systems. Overall, there is an urgent need to develop information systems which indicate which agricultural systems present the greatest threats to biodiversity and which are of greatest benefit, as well as identifying their location and the particular farming practices which determine the environmental effects. Only once this basic information is available will it be possible to evaluate the key drivers (policy, socio-economic and technological factors), and hence the most appropriate means of addressing biodiversity loss.

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**Small Mediterranean islands and biodiversity**

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The Mediterranean region is of value to global biodiversity due to its wealth of species, high rate of endemism, long history, and tolerance of all kinds of disruptions, as well as for its role as a natural laboratory for evolutionary studies. With almost 5000 islands and islets, the Mediterranean comprises one of the largest group of islands in the world. These make an invaluable patrimony in terms of nature, beauty and cultural heritage. The continuous environmental pressure maintained by humans throughout history is an inescapable component of all Mediterranean ecosystems. Over the last few decades, however, major socio-economic changes increased the negative impact of such human activity. In this respect, small islands are vulnerable, as their size and extensive coastal zone implies a tight 'coupling' to the atmospheric environment, enhancing the effects of disruptions. Desertification, biodiversity loss and invasions are the major threats presently menacing small islands of the Mediterranean. Climatic data of the last few decades show that precipitation is steadily decreasing in the southern part of the Mediterranean basin. Projections made by General Circulation Models predict further reductions, which would threaten the sustainability of fragile ecosystems. Atmospheric demand for water is increasing, due the higher temperature and the reduced humidity of the air. The combined effects of the two, will factor in longer lasting and more pronounced summer water deficits. Enhanced water use efficiency brought about by elevated atmospheric carbon dioxide may partly compensate, but the variable response of individual species adds further degrees of freedom, making the overall scenario difficult to predict. Vegetation cover of small islands may also determine feedbacks on the local climate: since plant cover of an island plays a role in the regulation of the total precipitation, reductions in the vegetation growth that may be caused by enhanced drought, will exercise negative feedback effects on water availability and with this, ecosystem sustainability. The direct impact of drought on growth and survival of plant species is expected to have a number of secondary effects on community dynamics. A modification of species abundance (cover) and competitive performance together with an alteration of the community invasibility are likely to disturb ecosystem equilibrium. Plant communities may shift to more drought-tolerant ones, favouring either species of previously minor importance for the total community production or external invaders. The lack of information on species distribution impedes any objective assessment of the current situation on the islands or islets. It is also difficult to plan conservation actions for species and habitats, as limited information on ecology, species biology or habitats exists, and on the response of these to future scenarios. Research is needed to quantitatively assess the impact of the different drivers of change by manipulative experiments (mobile rain shelters and rain exclusion devices, FACE, heating devices etc) and long term gas exchange monitoring (eddy covariance towers, stable isotopes analysis etc.). Projects are under way adopting all of the above cited approaches, and network have been established to assess the response of major continental biomes to global change drivers, while no such activities are presently running for small islands.

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**Small Mediterranean islands and biodiversity / The Mediterranean is a Sea**

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Most European actions about biodiversity, from Natura 2000 to Corine, are centered on terrestrial habitats. Also in this forum the Mediterranean is perceived as a land-based reality. The Mediterranean is what it is because there is the Mediterranean Sea! A proper balance between land and water is needed to respect the ecology of the Mediterranean. I am somehow disappointed by the topic of this forum. Not by what is discussed (all topics are very relevant) but by what is not discussed. All human activities end up influencing the sea. The Mediterranean region is what it is because there is the Mediterranean Sea! This is apparently forgotten. The main bulk of Mediterranean biodiversity is in the water; pristine habitats are in the water. The rest is greatly compromised by mans actions. I agree that we have to defend terrestrial ecosystems and biodiversity. They are very important. But this approach is almost totally neglecting the marine portion of the story. Also the species and the environments in Natura 2000 and in Corine are mostly terrestrial and do not respect the balance in the distribution of biodiversity within Mediterranean ecosystems. This biased approach has to be re-balanced since, often, terrestrial activities have a much greater impact on marine habitats than on terrestrial ones (everything we discard ends up in the sea). Of course this impact is not visible by those who do not work in the sea and is not perceived by locals. Agriculture is not only the cultivation of land. Fisheries are now part of what is called agriculture. Aquaculture is greatly impacting on the biodiversity of the

Mediterranean, also by the introduction of exotic species. The Mediterranean Sea is invaded by aliens and is going through a tropicalisation. If, for you all, Mediterranean means just the land, then I am not interested anymore to participate to this forum. As a final remark, though, I must say that ecology is the science of interactions, and the study of the Mediterranean region pretending that the sea is not there, is not a position that can be considered as ecologically correct. I derived this impression both by the European policy on biodiversity, by the introduction to this forum and by the contributions. Please, convince me that I am wrong, I will be happy to recognise my mistake and contribute to the development of a correct vision of Mediterranean biodiversity.

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**Small Mediterranean islands and biodiversity**

Helena Freitas
Universidade de Coimbra, Portugal

We all agree that Mediterranean marine biodiversity is as important as terrestrial biodiversity. The need to protect the fragile marine environments against growing environmental and economical and pressures is obviously shared by all of us. Although I am a terrestrial ecologist I am strongly involved in the national debate about the possible ways of conserving marine biodiversity by extending the Natura 2000 strategy in order to include marine areas and designing networks of marine reserves that are ecologically effective.

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**Small islands and biodiversity**

Adriana Vella - Dept. of Biology, University of Malta Malta

It is very relevant to consider the Mediterranean biodiversity found on Islands as well as in the sea surrounding these islands for the many reasons mentioned by Enzo Magliulo. Here perhaps I would like to highlight the danger of increased exploitation of coastal regions for various types of development without adequate and in-depth environment impact assessments. Thus ways of addressing EIAs, monitoring and restoration of exploited sites are urgent needs for small Mediterranean Islands. The same may be stated for fishing and fish farm activities around small islands in the Mediterranean and may also affect the marine ecosystem, especially when considered in synergy with the increasing factors affecting Mediterranean sea life. Certainly Mediterranean Islands have an important contribution to make, as stated by Enzo Magliulo, but this contribution may easily decrease with increased human disturbance and lack of resources or will to maintain scientific research, assessments, monitoring and managment procedures for the conservation and sustainable use of natural resources. Here one may wish to discuss how effectively has the idea of sustainable development been addressed in different Mediterranean Islands and how have islands with a dense population been seriously dealing with conservation of its limited resources.

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**Small islands and biodiversity: Threats to Biodiversity of Croatian Islands**

Vlatka Scetaric & Gvido Piasevoli

Gvido Piasevoli, Society for the Preservation of Biological Diversity "Falco" Split, Croatia & Vlatka Scetaric, Society for the Conservation of Nature and Environment "Eleonora" Zagreb, Croatia

There are almost 1200 islands, islets and rocks in the Croatian part of Adriatic. Inhabited islands are mostly economically undeveloped and their population is decreasing. Many of the traditional economic activities have been abandoned, but new activities, such as tourism, are increasing. Both processes cause various forms of degradation of nature and biodiversity. Although the islands' biodiversity is not researched enough, it is known that Croatian islands are rich with endemic taxa. Some of the islands are very small, and therefore potentially very endangered. Some taxa such as the carnation (Dianthus multinervis), endemic to a small, sheer and hardly approachable pelagic island of Jabuka were extinct even several decades ago. Nowadays the threats are far bigger. Most of the Croatian islands suffer from lack of freshwater and small freshwater pools are very important for biodiversity. Pools used to be maintained by local people, because of their importance for traditional agriculture, but now they are abandoned and rapidly disappearing. Disappearance of the natural vegetation could cause a decrease in food sources for animals. Forest fires are the biggest cause of disappearance of the natural vegetation, but some traditional economic activities also contribute and natural vegetation is rapidly decreasing. Irresponsible usage of agricultural poisons can also be a potential problem. Poisoning has not been registered in Croatia so far, but it has been registered in some other Mediterranean countries and could be expected to become a problem in Croatia. Alien plant and animal species find their way into Croatian islands' habitats by human design and by accident. When accidental introductions occur, the whole system can be distorted, but equally this can be the case with planned introductions. On the island of Mljet Indian, mongoose (Herpestes auropunctatus) was introduced, presumably in the belief that it would destroy poison snakes. The mongoose population grew quickly in size and number and soon became a potential danger for birds on the island. Some allochthonous species (cats, dogs, rabbits, rats, sheep and so on) were colonized on Croatian islands long ago, and it is likely that their density on some islands declines due the depopulation. On many of the Croatian islands the intensity of hunting is so great that it has influenced island biodiversity. Such activities, some of which are traditional customs (egg collecting and eating of bird eggs and chicks) are the major threat for pelagic island avifauna (Vis, Bi"evo, Svetac). Hunters also introduce some allochthonous species. Croatian islands are particularly vulnerable to tourist development. Urban encroachment, road routes, and waste disposal can potentially destroy most of the natural areas. Tourism has been a serious factor in the degradation and loss of nature area on islands (the illegal construction of summer holiday houses, discharge of untreated wastes, etc.). Well managed tourism can be compatible with the conservation of islands. In order to preserve natural values, it is evident that mass tourism involving construction of large hotels and tourist complexes should not be planned. In certain areas there is a need to restrict tourism at certain periods of the year (where rare plants occur or when colonial birds nest). Intensive urbanization and ship traffic close to colonies could interrupt breeding birds. This is very important, e.g. for species such is Eleonora's Falcon (Falco eleonorae), because during the parents' absence, eggs or young may be attacked by predators, and embryos in eggs could die of overheating. The potential economic benefits of island related tourism for local people could be profound, especially if

tourists, such as birdwatchers, are attracted outside the main seasons. Conservation efforts suffer from the lack of strategic approach, lack of public and political awareness of the islands values, weak conservation institutions, with a lack of trained personnel, inadequate laws and procedures and insufficient implementing of the laws and control. The Croatian islands and their biodiversity are still well preserved, but they are very endangered now, because the whole society is not able to protect them, due to the reasons mentioned above.

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**Mediterranean landscapes**

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1. Regarding the name of this meeting, I would have replaced "ecosystems" by "landscapes" for the following reason: As we have pointed out in our book on landscape ecology (Naveh and Lieberman, 1994) and elsewhere (see below), ecosystems are functional systems, which are spatially vaguely defined and have no clear borders. On the other hand, landscapes serve as the tangible spatial matrix for the functions of all organisms (including humans!), their populations, communities and ecosystems (see also Allen and Hoechstra, 1994!). Therefore the arena in which the fate of biodiversity will be determined, are the landscapes as the living space for organic variety on earth.
2. In the Mediterranean we deal with cultural landscapes which have been shaped throughout the cultural evolution of Homo Sapiens since thousands of years by human interventions through grazing, browsing, burning, cutting, and in the case of agricultural landscapes also by cultivation. These chiefly short and long time cyclic intervention - have created a dynamic flow equilibrium - or "homeorhesis", and in combination with the great micro-and macro-site ecological heterogeneity of the rocky and rough terrain and the fine grained agro-silvo-pastoral land uses, have induced the great biological, floristic and structural diversity in the Mediterranean Basin and especially in its non-tillable uplands, which could not been converted into agricultural fields or plantations. Presently this dynamic flow equilibrium- is distorted either by complete cessation or by intensification of human land uses, and therefore endangers also its biodiversity. We need a clear comprehension of these processes and their thermodynamic behaviour in order to be able to treat these threats in meaningful ways as semi-natural, human perturbation dependent landscapes, in which biodiversity can be conserved and restored only by the conservation and restoration of those ecological processes which have created and maintained this flow equilibrium in the past.
3. There is, however an additional very important aspect in dealing with these threats, and if these are overlooked, we miss the point: Because of these closely interwoven natural and cultural process, the biological diversity in Mediterranean landscapes is closely related with the unique cultural diversity or in short the ecodiversity. In many cases these are even mutually amplifying cybernetic relations. Their comprehensive study, assessment and conservation management as the true "Mediterranean heritage" needs a close cooperation of scientists from natural sciences, and especially landscape ecologists and from the social sciences and humanities. I support transdisciplinary, problem-solving research, as one of the most urgent scientific tasks to face these challenges, to be discussed in more detail in a follow up of your meeting.

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**Mediterranean landscapes**

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A landscape perspective on ecosystem functioning is essential to understand present and future changes in biodiversity. However at present, specific knowledge of how ecological processes develop at large spatial scales is very poor in the Mediterranean and we urgently need specific approaches concentrating in this region to develop sound management tools for biodiversity preservation. Certainly, a landscape perspective on ecosystem functioning (...may be a way to reconcile "ecosystems" and "landscapes") is necessary if we want to understand the main factors that affect biodiversity distribution in any regions, but especially in the Mediterranean area. However, in spite of the relevance that such a landscape perspectives increasingly meriting, our knowledge of ecological processes that act at large spatial scales (which include both traditional "natural" and human related processes) and affect key issues, such as species distribution, is surprisingly low. This becomes alarming when one focuses on Mediterranean areas. An example of how changes in landscapes affect biological diversity is habitat fragmentation. In particular forest loss and derived habitat fragmentation have become ecological study areas mainly due to their relevance on tropical, most temperate and boreal forest systems. In spite of the many unanswered questions, today we know quite a lot about the range of ecological effects that follow forest fragmentation. However, if one turns to the main habitat changes that will affect the Mediterranean in the near, mid-term future, one realises that ecological knowledge on possible ecological effects of landscape changes is too poor to allow useful predictions. Landscape changes here include changes in landscape heterogeneity (simplification of traditional landscapes), increased afforestation in many areas, fragmentation of open rather than forested habitats (which have been anyway fragmented for ages in the Mediterranean), and so on. Therefore, it is urgently needed to develop multidisplinary studies focussing on how landscape scale ecological processes work, specifically in Mediterranean areas, and especially important would be to conduct comparative studies with other areas to identify key elements in ecological functioning relevant to biodiversity conservation.

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**Mediterranean landscapes**

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Professor Naveh has set in his contribution a distinction between ecosystems and landscapes that may facilitate future conservation research in the Mediterranean. His phrase "landscapes serve as the tangible spatial matrix for the functions of all organisms (including humans!), their populations, communities and ecosystems" marks the 'arena' in which future conservation research will be carried out. What will be discussed here is the content of this conservation research. Professor Naveh is more than correct when he discusses interdisciplinary scientific cooperation in order to better understand, manage and conserve Mediterranean landscapes. The question is: who should participate in landscape conservation research and why? In answering this question one should first answer the question "What do we want to conserve in Mediterranean landscapes?" This question is not an easy one to be answered. Of course we want to restore, we want to conserve, we want to protect biodiversity in Mediterranean landscapes, along with protecting their 'traditional cultural diversity', the 'rural heritage' of an area. But restore what? conserve what? protect what? Are we sure that 'biodiversity values' and 'traditional cultural diversity' can be combined for all landscapes and all intervention or conservation practises? Professor Naveh is on the right track again when he discusses the anthropogenic and cultural character of Mediterranean landscapes, formed by interactions between societies and nature. But what were the landscapes that we now regard "traditional" actually like? If that question cannot be answered, then conservation research and practises will not conserve what they should conserve, apart from biodiversity that is. The points I am trying to make will be discussed through a specific example of a Mediterranean cultural landscape. In the following paragraphs I will sketch a short history of its content and the interactions between societies that manage the landscape, land uses and traditional character. Lesvos is a big Greek island (the biggest in the Aegean after Crete), located in the North Aegean. Records reveal that it is inhabited by agricultural based population for more than 3.000 years. Little can be deduced about ancient land uses at a major scale, except that cereals and olives were cultivated to some extent along with local sheep husbandry. In Medieval times, the Genovese administration of the island (13th to 15th centuries) attempted and succeeded partially in introducing more olive groves and vines, used for exports. However, the basis of the local economy was still cereals and animal husbandry. The Turkish administration that followed "supported" more cereals and vines for Istanbul supply. Limited olives were grown in semi-mountain areas with (limited and in specific areas only) terracing. Animal husbandry (sheep mainly) was also common but stock numbers per family appear to have been small. Later (18th and 19th century) developments in the olive oil market raised the price of olive oil so much that a shift towards olive oil cultivation occurred, along with a small but steady population increase, that caused major land use changes in specific areas, especially from forests to olive groves, along with extended terracing. This development had to be combined with industrial development in the field of olive oil production, soap production and leather manufacturing (up to the beginning of the 20th century), that raised olive groves up to 99% of the total agricultural utilized land in the East side of the island, along with cereals, vines and tobacco in the central-North part. This short period of time (100 years more or less) formed today’s landscapes, with extended olive groves on terraces and barren grasslands for sheep (in the West part), while cereal and tobacco production was abandoned. The modernization of agricultural production and maritime transport led to a decrease in the island’s industry and population, and a decrease in cultivated land.

Livestock numbers increased rapidly and olive groves and terraces were abandoned in a small but steady rate, especially in mountains and remote areas. Nowadays, the "traditional" landscapes are considered as landscapes of high aesthetic and symbolic value for locals and tourists and attempts to set up policy responses to abandonment and population decrease are made. The question that has to be answered now is "what is the 'traditional Lesvos landscape'?". Is it the recent landscape, which can not be considered as lasting for more than 200 years, is it today's landscape with abandoned terraces and desertified grasslands, or is it the "older" landscape of less groves and less Utilized Agricultural Area (UAA)? An obvious answer would be that the desired landscape is the one that supports more biodiversity. But are we sure about the effect such changes as the ones described above bring and, moreover, what about cultural features? The above short and obviously not adequate description of land use and landscape change can not answer that, but it can provide a way for answering the question Professor Naveh set forward: Who should be involved in "restoring" or "conserving" agricultural Mediterranean landscapes. Of course landscape ecologists, who can provide valid scientific knowledge on ecological processes and changes, on biodiversity values etc. But as the above have revealed, a team consisting of cultural geographers, agricultural scientists, economic scientists, demographers and rural sociologists is absolutely vital in order to understand better the complex interactions between societies, landscapes and ecological processes. Thus, conserving Mediterranean landscapes should be a multi-disciplinary task in design and operation.

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**Mediterranean landscapes**

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Replying to Zev Naveh and several other contributors to this conference, I would like to emphasize two points that, in my opinion, are two keys to understand the role and importance of biodiversity in the Mediterranean. First, what makes the Mediterranean almost unique in the main biogeographic regions of the Northern Hemisphere is environmental diversity that regularly (see Bell et al 1993, Oecologia) scales across local habitats, landscapes and regions. Depending on scale, the effects of environmental heterogeneity influence the composition, structure and diversity of populations, communities or the so-called metacommunities at the scale of whole landscapes. Environmental heterogeneity is particularly interesting and worth studying in the Mediterranean because it is both natural and anthropogenic. In some cases, where historical records, i.e. paleobotanical, are available, it is possible to make a distinction between these two components. For a while in the history of the Mediterranean, human impact had a definitely positive effect on biodiversity, e.g. when the Roman triad (Sylvia-Saltus-Ager) or the Dehesa - Montado systems opened the formerly rather homogeneous oak woodlands in many parts of the basin (see e.g. Blondel & Aronson 1993, 1999 for a discussion on the dynamics of the so-called alpha, beta and gamma diversities). For example, the ornithological archives report on many examples of bird species that naturally expanded their distributional range in the Mediterranean as a result of human action. One message of a historical investigation of Mediterranean habitats, landscapes and communities is that they are highly dynamic with dramatic ups and downs depending on climate changes and human impact. For example there is currently a 2% recovery of forests in the northern side

of the Mediterranean, whereas there is a still 2% decline in forests in the southern side, obviously the system is highly dynamic. Incidentally, this also makes the Mediterranean basin as a whole a dramatic microcosm of the North-South problems and inequality that people experience at a worldwide scale (see Blondel & Aronson 1999). In the decades to come climate change will have even more dramatic consequences on ecological systems but a key point is that Mediterranean systems as a whole are presumably preadapted to rapid and drastic environmental changes. This could perhaps make them less vulnerable than many other temperate, tropical or arctic/Antarctic systems to the current global change crisis. A very interesting and useful goal is to investigate to what extent and at which speed populations and species can cope with such rapidly changing environments. For example, we are currently studying in our laboratory the response of populations to rapidly changing environments, including global warming, using the blue tit as a study model in Mediterranean habitat mosaics. What appears from our studies is an astonishingly high phenotypic plasticity for many fitness-related traits of most populations to habitat heterogeneity. Depending on the geographical configuration of habitats within landscapes, local populations show either local specialisation as a result of a fine adaptive response to local selection regimes, or a maladaptation that makes populations a "source-sink" system at the scale of landscapes. One very promising issue would be to study in more details the gene-flow/selection tension that is of paramount importance in the adaptation process, and hence in the future of many species and populations in the Mediterranean basin, especially on islands. Second, genetic and phylogeographic studies have repeatedly demonstrated the importance of the Mediterranean, especially the larger peninsulas, as refugia for all the European biotas during the 20 or so glacial and interglacial episodes that have occurred during the Plio-Pleistocene (see e.g. Hewitt, 2000, Nature). For almost (as far as I know) all animal and plant species studied so far in this respect, there is an increasing degree of within-species inter-population genetic diversity. This means that in addition to its role as "winter quarter" for all the vegetation belts and associated faunas during glacial times, the Mediterranean has been a matrix for genetic differentiation. This makes Mediterranean populations of most European species and populations good candidates for "Significant Evolutionary Units" sensu Moritz (1994) and many mountainous and island regions of the Mediterranean for significant areas for conservation.

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**Mediterranean landscapes**

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I agree with previous contributors that there has been a great variety of factors that sculptured, amplified, and maintained up to date the splendid Mediterranean nature garden. Indeed, the biological diversity of this Eden, in the sense it has been used by Attenborough (1989), reflects the Basin's environmental heterogeneity as the result of continuous multi-scale changes, spatial and temporal. Among the major factors I would put the emphasis on the geological and climate ones which have greatly shaped the Mediterranean environment through time, and made many Mediterranean regions hotspots of diversity (Blondel and Aronson 1999). On the other hand, human impact in diversifying this environment cannot be disregarded: the roman triad, the dehesa – montado systems, the olive grooves of the Aegean islands, the salinas of the Mediterranean – coastal and inland –, the terraces for agriculture are landscapes shaped though the cultural evolution of Homo sapiens, and, thus, historical contributions of Mediterranean man to nature. The "landscape" issue, a mixture of nature and man-made characteristics, constitutes, in a way, the palimpsest on which deep long-term registers alternate with shallow and short-term ones (i.e. of the physical environment vs human interventions). Although I fully sympathise with and support the term "landscape" and its notion, my concern is whether there is still a confusion between conservation of Mediterranean "nature" and "landscape", probably related to the enormous impact of man in this region. Therefore, I would challenge the discussion herewith by submitting some questions on the matter: - As far as I can understand from the contributions within the present conference, there is no disagreement in that landscape perspective is essential for ecosystem/diversity conservation. However, I wonder whether it is somewhat risky to replace the classical concept of "species" and "habitat conservation" by that of "landscapes" which I fear are meant to be rather man-made than natural. - If we agree that the "landscape concept" (i) is biased by the scale of observation/ perception/understanding, and certainly by anthropocentrism, (ii) is more likely to be accepted and adopted for conservation due to man's psychological relation with the topic, then it would be necessary to re-define the relative importance of the above-described "natural Mediterranean garden" and "man-made Mediterranean landscapes". In this sense, it is no wonder that "eco-museums" vs natural zones are acknowledged and easily adopted for plain conservation, for the simple reason that they are much easier to understand and manage. - Indeed, what is a "traditional landscape" is difficult to answer, but let us try. Recently there have been several studies in Greece and elsewhere in the Mediterranean, trying to unravel archaic or classical landscape types and uses (Botema et al. 1990, Rackham and Moody 1992, Runnels 1995, Wells 1996, Wells and Runnels 1999, Christopherson et al. 2000, Petanidou et al. 2001 and references therein). In fact, archeology, paleontology, palynology, as well as very modern techniques like GIS are adapting to this arising question: what did Mediterranean nature look like during the Classical Greek Period – what was the world of Homer? As a result, many scientists came to important conclusions, little by little reconstructing the Mediterranean nature and its use in the past. Is that landscape traditional? My answer is yes, as long as there is evidence. In this sense, I would argue that the vague issue of "traditional" is always subject to new evidence and new research. I would go even further, by suggesting that the most traditional use is "no use", i.e. the pure nature alone. Unless this suggestion is halted by a definition that tradition and human use are interrelated. In this case time boundaries are delimited by human presence and use.

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**Mediterranean Ecosystems of Crimean mountains: Diversity, Conservation and Modelling**

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The Crimean mountains are a single region of The Ukraine belonging to Mediterranean Europe. The mountains of Crimea form a low isolated mountain range stretching 180 kilometers from south-west to north-east and reaching a maximum of 60 km. They cover an area 700,000 hectares. The highest peak – the Roman-Koch Mountain reaches 1545 m. Orographically, the mountain range consists of three parallel ridges: the highest main ridge (1,200-1,500 m), the inner ridge (500-800) and the outer ridge (up to 450 m). The ridges are divided by river valleys. The highest elevations of the main ridge are flat, table-like, hilly, mainly woodless and up to 10 km wide: they are called "yayla" (from Fatar word pashere). The plant life of the Crimean Mountains is extraordinary rich and unique. The vegetation consists of sub Mediterranean and temperature forests and also steppe. The main natural factors causing this diversity are the geographical location of Crimea, its orographic features and the proximity of sea. The southern and northern slopes of the Crimean mountains host three vegetation belts: 1. The lower sub Mediterranean belt (up to 400 m) of hemi xerophytic Quercus pubescens forests, which in some places has growths with Juniperus excelsa and Pistacia mutica. 2. The middle forest belt (400-800 m) of meso xerophytic and meso xerophilous woods with Pinus pallasiana and temperate forests dominated by Quercus petraea. 3. The upper forest belt (800-1300 m) of the beech Fagus silvatica and Pinus kochiana. The northern macro slope supports a different group of plant communities: 1. The lower forest belt (up to 400 m) on the outer ridge is covered by hemi xerophyte Quercus pubescens and steppes with Stipa and Festuca species 2. The middle forest belt (400-800 m) with temperate brood-leaf forests (Quercus petrea, Carpinus

betulus, C. orientalis, Fraxinus excelsior) 3. The upper forest belt (800-1300 m) dominated by beech Fagus sylvatica. 4. The flat highest elevation of the ridge carries a special vegetation belt of meadow steppe with Festuca valesiaca, Stipa lithofila. In the Crimean mountains plant communities characteristic for other mountains of Europe are absent: broad leaf forests with Quercus robur, Acer platanoides, Acer pseudoplatanus, Betula pendula, Picea abies and treeless sub alpine and alpine belts. The flora of the Crimean Mountains numbers about 2300 species. On an area equal to 1% of the whole Ukrainian territories, almost half of the total Ukrainian flora can be found. The range of distribution of most species is related to Mediterranean. A high degree of endemism is characteristic for the Crimean flora. There are 240 endemic species. A quarter of them grow all over the Crimean Mountains (Helianthemum stevenii, Thymus callieri, Thymus tauricus etc) and 60 % only on the top-yaylas (Androsace taurica, Silene jailensis, Cerastium biebersteinii etc). 116 species of vascular plants including in Red Data Book of Ukraine protected in 4 nature reserves (zapovedniks) of Crimean Mountains: Krimskiy, Yaltinskiy, Mys Martyan, Karadagskiy. The problem of the conservation rare plant species in artificial forest ecosystems is real for the Crimea region and increased by anthropogenic impacts. We have unique experience of modeling the populations of plant species in cultivated areas in the National Botanical Garden Ukrainian Academy of Sciences in Kyiv. The phytogeographical plot "Crimean mountains" in National Botanical Garden was founded in 1950. The area of the plot is 2,5 ha. There are 236 species of plants (34 species of trees and shrubs and 202 species of herbaceous plant grow in the plot "Crimean mountains". There are species included in Red Data Book of Ukraine (1996) Cerastium biebersteinii, Crocus speciosus, Eremurus tauricus, Galanthus plicatus, Paeonia daurica, Paeonia tenuifolia and Taxus baccata among them. Rare species of Crimean flora Allium auctum, Cerastium biebersteinii, Centaurea cana, Dentaria bulbifera, Ornitogalum fimbricatum, Primula macrocalyx, Salvia tomentosa, Salvia scabiosifolia were formed in 50 year old artificial beech and pine forests stable populations similar to the populations of these species in natural habitats.

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**Biological Invasions and Mediterranean Biodiversity**

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To date the Mediterranean Basin has contributed more non-indigenous species to other parts of the globe than it has received. This tide is now turning, and the scale of problems faced by California, South Africa and Australia may soon become a European reality. Current Background: Biological invasions by non-indigenous species are widely recognised as a significant component of human-caused global environmental change, often resulting in a significant loss in the economic value, biological diversity and function of invaded ecosystems (Mooney & Hobbs 2000; Mack et al. 2000; Pimentel et al. 2001). In the United States, the cost of biological invasions has been estimated to total $97 billion hitherto for 79 major bioinvasions (Pimentel et al. 2001). A similar audit for Europe has yet to be undertaken, yet non-indigenous species comprise a significant component of European flora and fauna. For example, throughout Europe approximately 6% of all vascular plants and 5% of birds are established non-indigenous species. Non-indigenous species are widespread in the Mediterranean and threaten marine, freshwater and terrestrial ecosystems. Non-indigenous species may have fundamental impacts on Mediterranean ecosystems, including the altering of soil C and N fluxes (e.g. low decomposition rates for

Eucalyptus litter), reducing indigenous biodiversity (e.g. Carpobrotus spp. reducing natural regeneration of dune communities) and breaching the genetic integrity of species (e.g. Oxyura jamaicensis hybridising with Oxyura leucocephala). Future Perspective: Global biodiversity scenarios for 2010 (Sala et al. 2000) highlight dramatic future increases in biological invasions in Mediterranean ecosystems, proportionally more so than in any other global ecosystem. Furthermore, biological invasions are seen as one of the most important drivers of change in Mediterranean ecosystems, second only to land use change and more important than climate, nitrogen deposition or rising CO2 concentration. In addition, interacting effects among drivers suggest that biological invasions will be facilitated by rising atmospheric CO2 concentrations, warmer temperatures, greater nitrogen deposition, altered disturbance regimes and increased habitat fragmentation (Dukes & Mooney 1999). The urgency of the situation and the lack of coordinated problem solving are only just dawning on an unprepared world. Legislative Instruments: Current European legislation covers non-indigenous species but is not sufficiently comprehensive. Member States of the European Union have a commitment "to strictly control the introduction of non-indigenous species" (Bern Convention on the Conservation of European Wildlife and Natural Habitats) and eradicate those alien species which threaten ecosystems, habitats or species" (UN Convention on Biological Diversity). Both the "Habitats" and "Birds" Directives of the European Union also contain provisions to ensure introductions do not prejudice the local flora and fauna (Hulme et al. 2000). However, European legislation is restricted to: a) prevention of deliberate rather than accidental introductions; b) exemption of the major sources of accidental introductions e.g. forestry and agriculture species, biocontrol agents, introductions into zoological and botanical gardens; c) no commitment to eradicate or control established non-indigenous species. The European States also have a commitment "to report the existence, outbreak and spread of plant pests and of controlling those pests" (UN International Plant Protection Convention). Pests are clearly defined by the convention of potential national economic importance to the country endangered thereby". The "Plant Pests" Directive of the European Union provides lists of pest species that must be banned from being introduced into particular Member States. Such directives do not address threats to biodiversity. The use of non indigenous species in farming, forestry, aquaculture and for recreational purposes has increased in the Mediterranean during this century. Species may be imported because they grow faster (offering increased economic returns), because they feed on and suppress other species (biological control species), or simply because people like them (pets and many garden plants). In addition to these deliberate introductions, agricultural trade may itself facilitate the spread of aliens directly through accidental introduction of non-native species or indirectly by modifying the natural environment so that it becomes more susceptible to invasion. While deliberate introductions can be regulated and controlled, at least to some degree, unintentional introductions can be much harder to prevent even with rigorous inspection and quarantine procedures.

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**Traditional land uses and biological invasions**

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As some contributors have reported to this e-conference, biological invasions by exotic species are one of the major threats for the biological diversity of Mediterranean islands. This situation is not unknown in Minorca and we now present a good example. The LIFE Nature project that the local government (Consell Insular de Menorca) is currently developing, has as main objectives the control and elimination of the threats on the endemic flora of the island. Among them is the invasion by the alien plant Carpobrotus. This threat has major importance as it strikes mainly on the coastal zone, where a plant community with a high concentration of endemic plants such as Launaeetum cervicornis (formed mainly by thorny cushion shrubs) is located. In a particular place of the island (cap de Favàritx) the invasion is so severe that the plant covers 100 % of soil surface in large patches. In this situation the elimination of the alien plant can be an important environmental impact, as the soil will become devoid of vegetation for a long time before the original vegetation recovers. To minimize the negative effect of massive Carpobrotus eradication, a study to set the proper eradication and vegetation regeneration methodology is currently being undertaken. However, the total elimination of the Carpobrotus threat will only be when we know and control the causes that have favoured its expansion. We can remove the alien plant now, and temporally control it, but if the factors that have helped its expansion still exist then the alien plant will come back again. So it is essential to know the history and evolution of Favàritx's landscape. We know that Carpobrotus has been cultivated in Menorca for a long time (Rodriguez, 1904). The relationship between coastal urbanization and Carpobrotus invasion is strong for most of the coast of Menorca. The plant easily escapes from gardens to the nearby wild zones. But Favaritx, at the moment, has been free of the urbanization process, this zone has harsh climatic conditions (windy, strong sea influence, etc.) and the soils are poor and thin. The land use has been limited to grazing. A lighthouse and a military position both established in the twentieth century seem the most probable focus of the Carpobrotus invasion. Also, from the landowners of Favaritx, we know that the expansion of the alien plant in Favaritx began by 1970. It is just

at this time that the tourist boom in the Balearic Islands started and, in consequence, the rural depopulation that led to abandonment of many traditional uses of the land such as extensive, but controlled, grazing. Although the seed dispersal of Carpobrotus by animals have been proved (D'Antonio, 1990). It seems that in the particular case of Favaritx, traditional grazing has operated as a restriction to the expansion of this plant. In fact, in other parts of the island with similar conditions, where grazing still exists and Carpobrotus is cultivated it doesn't expand, it remains only where the cattle don't graze (i.e. inside the fenced off area of a lighthouse). This can be an example of how the suspension or change in traditional land uses can be a loss of biological diversity and an open door to new problems.

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**Traditional land uses and biological invasions**

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Last year I made a geobotanical evaluation of an area situated in the littoral zone just north of Lisbon in the Parque Natural de Sintra-Cascais. The area in question consists mainly of dunes on cliffs. The present vegetation still includes elements or examples of the biotopes listed in the annexes of the EU 'Habitats' Directive, especially at or near to the cliffs. The dunes include more or less two types, namely 'grey' and 'green' dunes. The 'grey' dunes may be covered with the Armerio welwitschii-Crucianelletum maritimae. The 'green' dunes are stabilized dunes and partly covered by the Osyrio quadripartitae-Juniperetum turbinatae. The dunes are increasingly invaded by alien species, mainly Acacia longifolia and Carpobrotus edulis. Carpobrotus invades open vegetation, replacing most of the native species. The influence is especially negative for fixed dunes with herbaceous vegetation, a priority Natura 2000 biotope. The influence of Acacia longifolia (and also A. melanoxylon) is especially negative for the Juniper scrub, a priority Natura 2000 biotope. Both species have been introduced to fix the dunes and are actually replacing a number of important (Habitat Directive Annex II species), often endemic plant species and thus causing a major ecological disaster. It is expected that the nature value of the area will diminish more and more if there is no management. - Hypothesis of invasion patterns and processes - As far as I know not much is known about how to get rid of Acacia and Carpobrotus, except for cutting or pulling out. I believe that the invasion mechanism of Acacia and Carpobrotus takes place primarily in the 'grey' dunes. It is here that their competition force seems to be best. From the 'grey' dunes they can invade other biotopes. Competition may be enhanced by frequent activities of off-the road vehicles that move masses of sand covering the original vegetation. Carpobrotus may easily overcome that problem by growing over the sand, profiting from the extra flux of nutrients caused by the supply of fresh material thrown by the tyres of the cross vehicles. Acacia invades both open vegetation (with or without Carpobrotus) and scrub vegetation, finally replacing all original species. The

comparison between the present and past vegetation from almost 20 years ago is revealing that especially the so-called 'incultos' have been most quickly colonized by Acacia. The soils of these 'incultos' must have been more altered than those where natural and semi-natural vegetation occurs (more erosion? more fire? more dynamics?). Perhaps the dynamics of tilling followed by abandonment have accelerated the process of colonization. The presence of 'incultos' does not necessary mean that the area is not cultivated. Nowadays the area is abandoned: traditional agriculture is hardly competitive, especially with the increasing leisure industry. Without any management we expect that the area finally will be totally covered by Acacia. It seems worthwhile to study the distribution of Acacia in relation to the patterns of former land use and abandonment. Of course the hypothesis should be tested that the invasion mechanism takes place primarily in the 'grey' dunes. Since it is assumed that the first major invasion would be mainly in the 'grey' dunes it seems worthwhile to investigate the distribution pattern also in relation to soil type and soil treatment. Recently there was no wildfire in the area, at least as far as I know. However, besides soil type, soil treatment, and abandonment of 'incultos', former burnt areas should be also taken into account while tracing the major factors facilitating the expansion of Acacia in coastal areas. Nowadays cartography of former land use, 'grey' dunes, wildfires and distribution of Acacia should not be too difficult with the GIS system of the Parque Natural de Sintra-Cascais. Future study should also take the effects of off-road vehicles into account. In addition, research is needed to understand the population biology of Acacia longifolia and other Acacia species. - Management - In the present situation there is no management in the studied area and alien plant species will increase more and more. Management is needed indeed, but then the question arises: what kind of management? Nowadays it is very difficult to stop the increasing pressure on the littoral zone, especially near large agglomerations like Lisbon. The amenity of the area and the lack of space in Lisbon are major factors triggering the stream of visitors. The infrastructure of the tourist industry and second homes is consuming more and more space and the areas that may be covered by native vegetation are conquered by alien species. The foundation of a Natural Park in 1994 was a major step towards a guided development in the protection of nature and culture functions in the region. It is a fact that both Park authorities and people that live in the coastal area will have to deal with the large amount of tourists that visit the region. We often hear the advice: 'Kill not the goose that lays the golden eggs'. Well, the coastal zone will be totally covered with buildings in the near future and it will lose most of its original attraction if the authorities don't take action. Natura 2000 may be an important tool. However, an authority with merely prohibitory rules is not accepted in modern society. Economy and ecology should go hand in hand. The authorities should aim at raising the social basis for nature conservation by giving good information and stimulating private initiatives. It is also important that infrastructural functions, landscape and biotopes are geared to one another. Part of the profits of tourism may be used to manage nature sufficiently. In these days of withdrawing authorities there is an urge for viable private initiative in nature management. There are several possibilities to stimulate private initiatives and it is worthwhile to find out which ones can be applied or which ones may be created. Therefore it should be investigated if there is a legal basis for management contracts, if there are fiscal advantages for nature management (e.g. less tax for the owners, green tax on each night spent by visitors in the Natural Park), and if there are possibilities to be eligible for subsidy (Portugal or European Union).

**Global Change and Terrestrial Ecosystems - GCTE's challenges in biodiversity research**

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1. The relationship between biodiversity and ecosystem stability/functioning, (largely biogeochemistry and physiology), will remain a fundamental agenda in biodiversity research. As we have learned that individual species are important, efforts to develop functional classifications to be used in predictive tools such as models will also remain essential. Such classifications will depend on the spatial and temporal scales under study (there is not a universal classification). This will provide critical information (i) to predict biodiversity responses under different global change scenarios, and (ii) to test management priorities when they seek to manipulate species composition directly, for example, in complex agro-ecosystems, forestry, or ecosystem restoration (terrestrial and freshwater). Special attention will be devoted to search for possible thresholds and abrupt nonlinearities in ecosystem functioning due to changing biodiversity.
2. The traditional approach in community ecology has considered species diversity as a dependent variable controlled by abiotic conditions and ecosystem-level constraints. The traditional approach in ecosystem ecology has primarily focused on dominant species as biotic controllers of ecosystem processes. Recent approaches have broadened the perspectives of both sub-disciplines by assessing the role of biodiversity as a potential modulator of processes. In reality, there are mutual interactions among biodiversity changes, ecosystem functioning, and abiotic factors. Integrating these interactions into a single, unified picture, both theoretically and experimentally, and across ecosystem types and processes, is a major challenge which may help bring about a true synthesis of community and ecosystem ecology.
3. Among all contributions of biodiversity to ecosystem stability and functioning, there is the need to focus on functions that are most valuable to regional and global societies (i.e., ecosystem services). That will require a major effort in developing techniques to scale up in space and time our current knowledge, largely acquired from small-scale plot experiments, to those scales relevant and linkable to methods of socio-economic assessment and value. Likewise, contributions of biodiversity to Earth system functioning will be a goal of new research over the next few years.
4. Extend current knowledge on plant-based processes in Mediterranean grasslands to other organisms (animals, micro-organisms), other trophic levels (herbivores, predators, decomposers) and ecosystem, especially woody systems.
5. Changes in agricultural practices in Europe towards “greener” methods are leading to significant changes and redistribution of local biodiversity across the region. Changes in the demographic structure and spatial distribution of human populations with the increasing trend towards globalisation would entail important changes at an accelerated pace on the pressure of land use at various spatial scales. It is essential to understand the effect of landscape changes on the dynamics of biodiversity in relation to the functioning of terrestrial ecosystems across successional stages.
6. Potential impacts of biological diversity on human health. Changes in land use, with accompanying decreases in local and regional species diversity, entail the simplification and progressive homogenisation of the landscape in which diseases might spread with greater ease. Historically, approaches to the study of infectious diseases in humans and

livestock have focused on treating infectious agents and developing medicines to combat them. These approaches have rarely considered the infectious agents (virus, microbes and parasites) within their ecological context at a scale larger than the vector transmitting them. What is, for example, the influence of habitat fragmentation, deforestation, climate change and invasive species on the occurrence and rate of transmission of infectious diseases? What is the role of microbial diversity on the interactions between host-parasites and the emergence of infectious diseases? If such relations could be shown, they would be very important when accounting ecosystem services and assessing the importance of preserving the integrity of biodiversity and ecosystem functioning.

7. It is essential to develop new methodologies to develop scenarios of biodiversity both to be used as an input driver but also in interactive mode with climate, atmospheric and land use change drivers. This will provide assessment tools to develop alternative future options suitable for policy debate and societal choice.

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**Terrestrial-marine biodiversity linkages**

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Boero's consideration on the importance of marine biodiversity in the Mediterranean areas is not far from reality. The biodiversity of Mediterranean coastal habitats depends on the features and management of the coastal terrestrial belt and vice versa (e.g. aquaculture influence land ecosystems too). In my opinion studies on biodiversity conservation actions must involve, much more than at the present time, consideration of terrestrial and marine coastal systems. In fact, ecologists are now aware that population and ecosystem dynamics are rarely confined within a local area and that the factors outside a system may substantially affect (and even dominate) local patterns and dynamics. Local populations and the derived trophic structures are linked closely with other populations through such spatially mediated interactions as source-sink and metapopulation dynamics, supply-side ecology, and source pool-dispersal effects. Therefore, the consideration of both spatial scaling and the reciprocal effects of the landscape different contexts, as the movement of nutrients, detritus, prey and consumers, requires the integration of landscape ecology and population or food web ecology. This integration must be done in biodiversity conservation studies in both marine as well as in terrestrial ecosystems, especially in the Mediterranean environment where the coastline is very long and ecologically important. Although experimental studies on the specific context have facilitated insight into the mechanisms that underlie the inner working of a particular system, they have also meant that ecologists have specialized on studying a particular type of ecosystem without any direct cross-linkages. Consequently, many unanswered questions remain about potential linkages or differences among ecosystems and environmental contexts like vegetation vs. animal or microbial communities, Lotka-Volterra vs. donor controlled population systems, etc. On the global scale the impact of declining species diversity on ecosystem functioning has been receiving increasing attention by ecologists as the loss of species in many ecosystems has been documented but predicting the consequences of this loss (specially on the functioning of ecosystem) is difficult. The goal of biodiversity conservation becomes strictly related to the management of both ecosystem health and exchanges among neighbouring ecosystems, which requires an improvement of the knowledge existing on ecosystem processes also at landscape scale, with a special focus on the relationships

between processes and structures as well as on the environmental context dynamics within the landscape.

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**The Ecological Footprint and Biocapacity of Spain in 1998**

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Introduction

Among the indicators of sustainability proposed, one of them, the ecological footprint, EF (Warkelnagel and Rees, 1996), is very successful as a measure of the sustainability of the economic policy of a particular country, a crop, an industrial process, the way of life of a society or an individual, etc., due to the clarity of the term and its capacity to demonstrate what is and is not sustainable. The EF measures the ecological impact of a human action on the environment, in terms of the area of the land needed to absorb such an impact or sustain the production or consumption of a good by an individual or community. For example, the impact of wheat consumption by Spanish people in 1997, may be expressed as the number of hectares needed for growing the quantity of wheat that an average Spaniard consumed in that year; that is 0.035 ha. (3,647,000 tonnes of wheat, divided by the yield of that crop in Spain, 2,63 Tm/ha, and the Spanish population in that same year, 39,613,000) (Hernandez Laguna, 2001.) Extending the calculation to all, or most or the appropriations of the natural habitats made by a country's economic activity, we can quantify quite accurately the magnitude of the impact in terms of the biosphere surface needed to sustain its economy and eliminate its waste materials. The appropriations or uses of land considered in the calculation of the EF are the following ones: consumption of fossil fuels, built-up land, pastures, arable land, forests, and marine areas. In order to be able to understand if a country is destroying its natural capital or that of one of the countries it trades with, we have to compare this country's EF to its biocapacity for producing and maintaining resources. Due to the fact that the EF has been calculated using global yields, BC must be also calculated using the basis of the same yields. For that purpose we will multiply the area per capita available to each land use by its yield factor, which is understood as the quotient between global and local yield (Chambers et al, 2001, p. 119). Once the total EF of a country is compared to its productive BC, if the result is negative there is ecological deficit – what is taking place is the destruction of the natural capital of that country or any other country from which productive capacity is being imported, or "overshooting". The situation is unsustainable. This ecological deficit works as a meter to measure how much we are distancing from sustainable development.

Discussion and conclusion

The EF has become a useful indicator of sustainable development in order to quantify humanity's impact on ecological systems, not only to experts but also to all individuals. Its great communication capacity is based on the relative simplicity of its measurement – hectares of land surface necessary to support human action. It gets a maximum degree of transmission of the ecological load of a particular unit of study when comparing, for example, different countries. Therefore countries are classified from those that make less impact to those that involve a heavier load on global ecological systems. So, I have calculated in this paper Spain´s EF and ED in 1998, the latter being 4.1 ha/pc, higher than

the average word ED of 0.73 ha/pc (Warkernagel et al, 1997), but much lower than one EE.UU. inhabitant, whose ED in the same year would be 17.2, pointing out that if the 5,848,739,000 world inhabitants in that year, adopted the average American's way of life, three planets would be needed to house them (Warkernagel, 1996, p. 15.). Spain´s EF follows European countries numbers: so Italy had an EF of 5.6 ha/pc in 1997, France 7.2 in the same year (http://www.rprogress.org), without considering the EF of water consumption in both case. Although the calculation of EF and ED in one year could seem a static measurement (Warren-Rhodes and Koenig, 2001), nevertheless, they become a way of ecological accountancy if we calculate them in successive years, competing with and overcoming convention always as the GNP (Gross National Product) and other economics indicators which don't include the exhaustion of Natural Capital, even considered in some cases the national income (Chambers, 2001.)

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**Scales for monitoring biodiversity in Mediterranean landscapes**

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Biodiversity is a paradigmatic concept that takes a place in each organization level (genetic, population, species, community, ecosystem and landscape). High scores of diversity, in any

way that we can measure it, may be translated into “well being” for biological systems and positive valuation about ecological sustainability from populations to landscapes. At global scale there are some regional hot spots for biodiversity – the Mediterranean region is one of them. There are some reasons for this, including topography, biogeography or climate, but maybe the evolution of human settlement and human land uses are in the basis of actual biodiversity in the Mediterranean basin. Traditional land uses in Mediterranean region have been supported in a fragmented territory with no land without management. Almost all Mediterranean landscapes are cultural landscapes and current biodiversity is the consequence of ecosystem evolution in a human intervention context. The previous paragraph is important for the assessment and monitoring of biodiversity. If biodiversity values change in spatial and temporal scales it will be necessary to define mean biodiversity baseline values for each ecosystem or land use typology. In this way, the aggregation of biodiversity values from adjacent land uses and ecosystems firstly in a local scale and secondly in a regional one, can be a new indicator for detecting changes in biodiversity at the Mediterranean landscape level. We are aware that this integrated approach is based on a minimum sample size, the local landscape of a municipality. We consider this minimum administrative territorial unit because it provides population census and other socio-economic data despite being of less ecological relevance. Nevertheless, local land use change can affect biodiversity. Combining adjacent municipalities, gives us the opportunity of understanding biodiversity at a wider scale, meaningful in an ecological sense that involves regional landscapes. Only at this scale, some of the currently used indicators (keystone or specialist species, forest management variables, or landscape synthetic metrics like naturalness or connectivity) can be seen to be useful tools for assessing biodiversity changes. All measures of biodiversity are made on a territorial basis; from local to regional level, and the current methodology for analysis and integration of these data are Geographical Information Systems (GIS). In this context not only Special Protection Areas (SPAs) or Habitats can be monitored but also singular or representative Mediterranean landscapes.

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**Session 1 - Summary of of the 1st week of E-conference**

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The biological richness of the Mediterranean biome and the complexity of its conservation was strongly emphasised during the first week of this e-conference: from its unique cultural diversity and demand for interdisciplinary approaches, to landscape processes and ecosystem functioning, from economy to land use history, in both terrestrial and marine ecosystems. Several topics were covered and I will try to summarise them.

Mediterranean landscapes and the need for interdisciplinary approaches to preserve biodiversity

Biological diversity in Mediterranean landscapes is closely related with the unique cultural diversity. Zev Naveh emphasised the need for comprehensive studies, assessment and conservation management of biodiversity in Mediterranean ecosystems in close cooperation of scientists from natural sciences, especially landscape ecologists, and from the social sciences and humanities. Kizos Thanasis used the example of the island of Lesvos, in Greece, to explain the need to develop multidisciplinary studies, combining ecological and conservation work with demographic, economic, social and land use reconstruction of the societies that form the landscapes. Lluis Brotons also stressed the need to develop multidisciplinary studies focusing on how landscape scale ecological processes work, in Mediterranean areas, to understand present and future changes in biodiversity.

Mediterranean islands and marine diversity

With almost 5000 islands and islets, the Mediterranean comprises one of the largest group of islands in the world, with an inestimable natural and cultural heritage. During the recent decades, major socio-economic changes are taking place in the region with significant negative environmental and social impacts. In this respect, Enzo Magliulo considered that small islands are particularly vulnerable. He also emphasised that desertification, biodiversity loss and invasions are the major threats presently menacing small islands of the Mediterranean. Adriana Vella considered that it is very relevant to think about the Mediterranean biodiversity found in islands as well as in the surrounding sea. Ferdinando Boreo argued that most European actions about biodiversity are centered on terrestrial habitats and that a proper balance between land and water is needed to respect the ecology of the Mediterranean. Loreto Rossi agreed with this view and stated that the biodiversity of Mediterranean coastal habitats depends on the features and management of the coastal terrestrial belt and vice versa. Studies on biodiversity conservation actions must involve terrestrial and marine coastal systems, especially in the Mediterranean environment where the coastline is very long and ecologically important. Yves Henocque stated that the alteration and destruction of marine and coastal habitats through improper development practices and poor management are important conservation problems of Mediterranean ecosystems. All around the Mediterranean basin, coastal urbanisation is corresponding with biodiversity loss, stable increase of water demand, as well as of wastes and thus pollution. The creation of marine protected areas for conservation purposes is often not sufficient. Yves Henocque stressed the need to identify an ecological network of habitats in the Mediterranean which could serve as the focal point for the protection of selected species.

Seagrass beds could be one of the first selected habitat for such a networking, considering their crucial ecological role in Mediterranean coastal waters.

Biological invasions in the Mediterranean region

The spread of exotic invasive species has become an issue of international concern. Their global impact has been recognised in the Convention on Biological Diversity which calls for the control and monitoring of exotic species that threaten ecosystems, habitats and species. Non-indigenous species are widespread in the Mediterranean and threaten marine, freshwater and terrestrial ecosystems. Phil Hulme argued that non-indigenous species may have fundamental impacts on Mediterranean ecosystems, including the altering of soil C and N fluxes (e.g. low decomposition rates for Eucalyptus litter), reducing indigenous biodiversity (e.g. Carpobrotus spp. reducing natural regeneration of dune communities) and breaching the genetic integrity of species (e.g. Oxyura jamaicensis hybridising with Oxyura leucocephala) In the Mediterranean, problem species will become more problematic, benign species may become more widespread and further taxa will be introduced. Without comprehensive legislative instruments and background data, the Mediterranean Basin faces a major ecological challenge.

The importance of agriculture for conservation of biodiversity in the Mediterranean region

Agriculture has an enormous influence on biodiversity in the Mediterranean region. In particular, the processes of intensification and rationalisation of agriculture of the past 30 years have led to a wide range of ecological impacts. To Guy Beaufoy, there is an urgent need to develop information systems indicating which agricultural systems present the greatest threats to biodiversity and which are of greatest benefit, as well as identifying their location and the particular farming practices which determine the environmental effects. Only once this basic information is available will it be possible to evaluate the key drivers (policy, socio-economic and technological factors), and hence the most appropriate means of addressing biodiversity loss.

Research needs in the Mediterranean region

Pep Canadell discussed the need to develop new methodologies to improve scenarios of biodiversity both to be used as an input driver but also in interactive mode with climate, atmospheric and land use change drivers. This will provide assessment tools to develop alternative future options suitable for policy debate and societal choice To Yves Henocque the protection of species and habitats in the Mediterranean needs an integrated ecosystem approach, based on the certainty that an ecological network should be protected and restored when and where necessary. He also emphasised the urgent need for inventories of habitats and for the development of long-term monitoring programmes at the national level, developing standardised methods as much as possible. Increased attention should be devoted to the concept of eco-regions. Valuation of ecological goods and services is important since an obstacle to the inclusion of environmental concerns in environmental planning and decision making is the translation of ecological data into useful information for planners and decision makers. Sustainable environmental planning and management require effective integration of ecological, socioeconomic, and institutional elements. Enrique Hernandez-Laguna suggested the use of the indicator Ecological Footprint (EF), which, based on biophysical terms, transform the human consumption of Natural Capital

into the amount of land needed to provide it. The EF must be compared to the Biocapacity (BC) of the territory to supply the goods and services that are consumed, in order to get information about the degree of the sustainability of the a human system (country, region city, etc.).

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**The Biodiversity in the Mediterranean and Black Sea ecosystems**

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The Mediterranean ecosystems and the Black Sea ecosystems have a great similarity especially when you take into account that the species composition and biodiversity of these seas are a result of historical evolution of the territory (especially climatic changes), diversity of habitats and man influence. The composition and structure of the marine communities is constantly changing with the destruction of certain species and expansion of others. In the Black Sea region, the structure of marine ecosystems differs from the Mediterranean Sea as species variety is lower and the dominant groups are different. In the same time the abundance, total biomass and productivity of the Black Sea are much higher than the Mediterranean Sea. Habitats on the sands and salty soils represent important vegetation types, which are more, distributed in these biogeographic regions as part of Europe. There are a few main influences on the biodiversity of the marine ecosystems recognised in both of them. For examples: - For the aquatic ecosystems, the eutrophication through agriculture, industrial activity and inputs of insufficiently treated sewage are an important problem. In the same time contamination through input of harmful substances, and especially oil products and introduction of alien species are also important issue. - Changes in the Ichthyofauna. The composition of the Black Sea's Ichthyofauna has changed in response to alteration in living conditions in the sea. Some of the changes had an impact on costal and shelf waters; others on the pelagic zone, affecting common and rare species, young and adults, commercial and non-commercial species. - For the terrestrial ecosystems situated in the buffer coastal zone, which comprises the beach belt and sandy dunes in the vicinity of seashore, the main influences are tourism and agriculture. In the Romanian part of Black Sea, the plant culture is extended on the arable soils, grasslands are utilised both for mowing and grazing of domestic animals. Many grassland types are not only used for production, but they are maintained by man's activity - their existence depend on specific types of management. Grasslands on the salty and sandy soils are relative fragile and non-intensive grazing is only type of management, which maintain and don't damage these habitats. Agriculture is in a state of drastic transition as a result of the political and economic changes that have occurred in the last several years. The most part of rivers in western Black Sea region are tributaries of the Danube or of the Maritza (Aegean Sea). The Danube Delta, including the Razelm-Sinoe lake complex, which has an area of 580,000 ha, is the largest costal wetland complex in Europe. The Danube Delta has a triple status. It has been a World Natural and Cultural Heritage Site (since December 1990) with more than 50% of its territory in Romania (the other parts are in Republic of Moldova and Ukraine), a Biosphere Reserve within the UNESCO-MAB Reserve Network (since September 1990) and a Ramsar Site (since May 1991). Since 2000 it has been an international protected area (the Ukraine part was also declared a biosphere reserve). Main marine habitat types in both regions are protected under the EU Habitats Directive. In the Romanian part of Black Sea it was described overall habitat representation of existing (and

proposed) protected areas. Do they contain a full representation of important species and habitats that are found in the area? In order to answer to this question, every effort should be made to increase representation either by expanding the reserve or by providing sound conservation management in the buffer zones. The habitats situated on the seaside are definitely a priority status for threats. The special measurement for protection is not sufficiently. It is an important fact that in 1993 was initiated The Black Sea Environmental Programme (BSEP) at the urgent request of the governments of Bulgaria, Georgia, Romania, Russia, Turkey and Ukraine. It is important that we develop an updated Action Plan and strategies and recommendation for long term. Of course, remains the problem to find the financial support for long term implementation of strategies and recommendations.

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**Mediterranean Ecosystems Conservation (and Mitigation)**

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Large areas of the Mediterranean region are characterized by difficult biophysical conditions to agricultural development, due to a combination of several factors. Along the centuries, the human communities living in these areas have developed and improved agro-systems carefully adapted to the existing limitations, often integrating various components which are complementary to each other and allow the economic sustainability of the system in face of strong annual fluctuations in natural conditions. As a result, Mediterranean rural landscapes have developed as specific and highly diversified landscapes, where balanced farming systems correspond at the same time to very rich ecosystems. Differently from what happens in many other regions of Europe, these cultural, man-made, ecosystems have a very high value for conservation. But the required sensitive human intervention has been under pressure in the last decades, and many of these ecosystems have already disappeared, or are progressively been reduced, or changed, or are at the least threatened. Trends are both in the sense of intensification and extensification, but both lead to poorer systems and more homogeneous landscape patterns. Even if many Mediterranean farming systems are recognised as high value systems, not only for conservation, but also as cultural heritage, local identity, and landscape diversity, there have been until now no effective measures for the preservation of these systems, since they have not been considered in an integrated perspective. Conservation policies have mainly been looking at strict nature conservation interventions, while the need is for a close cooperation with the agriculture policies and also with the more social policies. These should create the conditions for life quality in the rural world, and therefore for maintaining people in the countryside, which can then maintain the farming systems. And agricultural policies should make the instruments

available for the systems themselves, shaping and monitoring these instruments also through assessment by the conservation authorities. Conservation of Mediterranean ecosystems requires a strategy that can today not any more be isolated from the socio-economic drivers and mainly from the related strategies and policies.

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**Bio-Cultural values at the landscape scale**

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Thanks to many contributors to have emphasized, after Zev Naveh, the importance of the landscape scale to understand (spatial) mechanisms, including human activities. Cultural concerns, notably, have a maximal impact on environmental management at this level. The initial challenge is to keep a memory of past ecosystems and human activities, and for that to maintain some habitats and species, through adapted uses. Keeping a memory means maintaining a different (conservative) management here and there inside a globally evolving matrix. As for urbanism, these memory plots may be only exceptions in the most transformed Mediterranean landscapes; their uses have changed and except in eco-museums we have to conceive new landscapes, which could be viable in terms of carrying capacity, and in terms of functioning. Moreover, in our economically developed societies we look for a continuous improvement of the functioning of the system, and more precisely of its value, considered as a quotation of durable interactions between environment and man (products, services, cultural values - including biodiversity in a certain way). Then, keeping the memory of past activities is a socially acceptable possibility to globally maintain and even develop biodiversity, by maintaining the diversity of the management practises. It makes simultaneously sense, then cultural value, and biodiversity, then bio-cultural value. The conservation of old trees, witnesses of past uses, aesthetically appreciated, and after a while possibly hosts of "new" rare species, is an example of this "conservation of the future".

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**Ecological and cultural values within the landscape approach.**

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There are already projects aiming to assess how a landscape approach can re-evaluate previously well established ideas which were based on ecological interpretations of planning and management policies that often failed to match the complexity of the Mediterranean region. I'm sorry I have not more time to spend on this topic, however, I would like to refer to issues raised by Prof. Naveh and to Dr. Kizos. The landscape approach has actually been taken as the leading perspective for projects that want to affect land management at all levels. Landscape is the result of ecological and socio-economic processes, thus, operating within a "landscape" perspective means to take into consideration, not only ecological factors, but also the driving socio-economic forces that actually played a major role in all environmental changes. This applies not only in the Mediterranean. The international project "Analysis, conservation and management of landscape resources" we are carrying out for the Regional Government of Tuscany (Italy), has the goal to analyse the ecological and cultural matrix of landscape, but also to assess a

method to answer questions like those posed by Dr. Kizos. Although we all agree in preserving landscape, is not easy to tell what landscape we are going to preserve , why and how. One of the most relevant issues about landscape conservation is that the value of the same landscape patch, with the same structure i.e.: a chestnut stand, a wood pasture, a mixed olives-vines cultivation, is never exactly the same in different times and different geographical areas. The combination of ecological and cultural values in these structures differs, according to the ecological and cultural context, which is so diverse all across the Mediterranean. Therefore, assessing the value of one landscape can only be done considering the interrelations among these elements in time and space. We find out that some generic questions asked by the policy makers who financed the project, like: "what to do with pine woods according to a landscape perspective?", have little sense if applied to an entire region. Only local investigation can properly address these questions, evaluating the context in which those woods developed and survive.

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**Complementary conservation for Mediterranean plant species**

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The complexity of the threats facing Mediterranean biodiversity mean that a variety of complementary approaches including in situ and ex situ conservation, together with the development and promotion of sustainable use activities, basic and applied research and education are likely to be required for the successful conservation of Mediterranean biodiversity and landscapes. This approach received high level support last week with the endorsement of the Global Strategy for Plant Conservation at the Sixth Conference of the Parties to the Convention on Biological Diversity. The Strategy contains targets for activities in all of these areas. In this context we were particularly interested in the contribution to this discussion from Victor Melnik (17th April) on the conservation of the flora of the Crimean Mountains. The short description of the work at the Ukrainian Academy of Sciences seems to suggest a complementary approach to conservation whereby ex situ plant collections are used to model the behaviour of the wild populations. Seedbanking is another form of ex situ conservation which can be considered for protecting Mediterranean wild plant species. Under this approach seeds from wild plants are stored as an insurance against the threats facing them in situ. The Millennium Seed Bank Project has collected and banked almost the entire native flora of the UK, some1450 species. We are now establishing collaborative projects with seed banks and other plant conservation organisations in a number of countries around the world, including regions of 'Mediterranean' climate and vegetation such as Chile and South Africa, as well as the Mediterranean itself (both North and South). These collaborations aim to build human and physical capacity for the long-term storage of seeds in the country of origin and in the UK. Although seed banking cannot directly protect the biological diversity of Mediterranean (or any other) ecosystems and landscapes, it can ensure the protection of diversity between and

within plant species – especially those at severe risk of extinction. Seed banks also provide options for the future conservation and utilisation of plants, including for restoration and re-introduction activities. The skills gained in seed banking, such as the development of effective germination and propagation protocols also contribute significantly to in situ conservation and sustainable use activities.

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**The historical (temporal) perspective**

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The important part played by the historical perspective in understanding Mediterranean landscapes was clearly emphasized by the eminent Spanish ecologist Fernando Gonzalez Bernaldez many years ago: "for the interpretation of the landscape and for correct natural resource managing, the historical perspective is a necessity" (Gonzalez Bernaldez, 1981). Without such an approach no rational management of natural resources is possible. But lamentably the temporal variable is usually ignored by researchers when dealing with their study object (in our case ecosystems; very probably because of the "specialized deafness", Kenneth Boulding, in Naveh, 1989). This is a terrible mistake, because the future is no less than the continuation of the past (Rull, 1990) and this fact has quite important implications for management issues, namely: "the present without a past has no future" (F. Braudel, in Geoparks, 1999). Scholars, managers, etc., frequently think that landscape history (ecological history, palaeoecology, etc.) only tells us about the wilderness which should be restored. But there is another (more) important topic: a long-term approach allows us to understand the dynamic behaviour of the system (which is fundamental for management) as well as the factors which have contributed to this dynamic and have shaped what we are seeing at present. Most citizens, policy-makers, managers and many scientists believe that Mediterranean landscapes are degraded (probably because of their [in some occasions] desert-like appearance, the lack of trees and because of the negative effects of some old-fashioned paradigms like the climax theory and the idea of progress in vegetation ecology). These ideas require urgently reinterpretation. The historical perspective shows that really these landscapes have been deeply transformed by our ancestors. But it demonstrates as well that indeed semiarid Mediterranean ecosystems have an enormous potential for recovery. So, for example, natural resources in the province of Almería (SE Spain, the most arid zone in all Europe) were intensively used during the last centuries (in the 19th Century they were overexploited, García Latorre et al., 2001). But during the 20th century (especially during the second part) vegetation has developed (Garcia Latorre et al., 2002) and the region belongs nowadays to the biodiversity hotspots of the Mediterranean Basin (Medail et al., 1999). So, the idea that these landscapes (general speaking) are degraded is in fact a prejudice (García Latorre et al., 2002). The historical perspective highlights the important part played by peasants in shaping these landscapes. In fact, the enormous biodiversity "stored" in the Mediterranean Basin is not only the result of ecological processes but also the complicated interactions between people and the environment, because of this, the term biodiversity should be broadened into the more appropriate "ecodiversity" (Naveh, 1994, landscape has a culture). These reflections make doubtful the practices carried out by the public administration in the framework of its programs for Nature protection and management. It would be more healthy to recreate some of the activities traditionally carried out by our ancestors; like maintaining some livestock in the country, controlled fires, etc. (González Bernáldez, 1990; Naveh, 1994). Of course, it is not

a question of returning to live old social structures, but of becoming inspired by traditional management practices and of applying them to the modern world for maintaining the ecodiversity (González Bernáldez, 1990; 1992). Although academically I was educated as forester, I doubt very seriously that afforestation (which has a long tradition in many Mediterranean countries like Spain of being carried out by public agencies) represents an appropriate method for managing Mediterranean ecosystems. So, the historical perspective would indeed be capable of changing (and making doubtful) traditional values deeply rooted in some professional groups with much responsibility in Nature management and protection but with many old-fashioned ideas. In short, a transdisciplinary approach in which ecological research is combined with a historical (temporal) perspective is a very appropriate way of understanding and managing Mediterranean landscapes.

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**The historical (temporal) perspective**

Tor-Björn Larsson - European Environment Agency

Research is needed that evaluates the impacts of tree plantations but it should be done in a wider ecological perspective. I fully agree with Jesus Garcia Latorre that "the historical (temporal) perspective" is important to understand present biodiversity patterns and to plan for the conservation of landscapes. First of all, before man become a major actor in the landscape, one might say there is a "biogeographical history". In most parts of Europe this, from a biodiversity point of view, is the post-glacial recolonization history. The Mediterranean is unique (in a European perspective) for having a much longer "biogeographic history". One feature of the long history is the speciation to be found in the Mediterranean islands (e.g. several vascular plants but even to be found in vertebrates like lizards). Preserving such patterns must be a high priority! It can parenthetically be noted that evolving (sub)populations also can be found in the large relatively undisturbed areas in

the northern Fennoscandia - this phenomena, albeit of much more recent origin, is also worth conservation interest! It is also very true that it is difficult to preserve the traditional land-use and its biodiversity values. I don't know of any example of "museum-type" nature conservation of traditional land-use, to which it is not possible to raise concerns about the long-term success from a biodiversity point of view. This is not because of incompetence of Conservation Agencies, but in the nature of the issue. One could, for example, point at attempts to preserve gene banks of crop varieties and breeds (but more often at the lack of such attempts, including the necessary research). But is it in the long term possible to preserve these genetic varieties in systems so different from the large-scale traditional land use during which they evolved? The same applies for the land-use systems as such, and other associated elements of biodiversity. However, being aware of these difficulties does not make it impossible to appreciate the efforts being done – and perhaps research can help to increase the effectiveness! Involvement of local people seem to be a key factor for success. Finally, being an occasional visitor to the Mediterranean with a forestry background, I would also support the concerns about afforestation. In principle it should not be negative to bring back a certain amount of forest in the Mediterranean. But there seems to be good reasons for encouraging research that evaluates the impacts of tree plantations in a wider ecological perspective. The evaluation should also include forest established through spontaneous succession. Factors to take into account, in addition to the benefits of wood production, include fire risk, hydrology, soil characteristics, insect damage, biodiversity (including a historical perspective!) and - not least - carbon sequestration.

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**The historical (temporal) perspective**

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We have surveyed the savannah-like montados of Southern Portugal for biodiversity in 60 sampling sites distributed over 2.7 million ha. The biological groups surveyed were plants, lichens, carabids, butterflies, and birds. For each site, we collected a set of environmental variables such as meteorological variables, soil type, and topography. A second set of variables described landscape metrics and land use. Lastly, a third set of variables described the socio-economic activities at each of the sites: through questionaires we obtained information on husbandry (breeds, stock density, grazing intensity, and others), agriculture (fallows rotation time, use of pesticides and fertilisers, and others) and forestry (cork harvesting, thinning and others). Each of the three sets of explanatory variables was significant on their own. One of the most interesting findings, though, was that the set of environmental variables explained about the same amount of variance as the two sets of anthropogenic variables (landscape structure and economics) together. These results show that humans and Nature both shape the montado ecosystem: the environment setting the raw ecological material, humans decoding and exploiting it. Although this coevolution has been suggested before (Di Castri, 1981; Blondel and Aronson, 1999), to our knowledge this is the first attempt towards the quantification of each part's contribution. We then looked deeper into the plants and birds data; by forward selection we reduced the initial number (100) of explanatory variables to 21 significant variables. Species richness of plants and birds were not correlated to each other: sites with high diversity of plants were not sites of high bird species, and vice-versa, which confirmed the danger of using one biological group as surrogate of biodiversity as a whole. The distribution patterns of either group,

however, did follow similar patterns: latitude and longitude showed up as the main drivers in both cases. Plant species showed a higher turnover as compared to bird species. This may be interpreted in the light of the different ecological requirements of either biological group. For example, in spite of the low range of altitude studied (25-450m), plant species responded quite well to variation in altitude: in the Mediterranean region, where water availability is an important limiting factor, altitude may lead to very distinct habitats in opposite hillsides: slopes receiving higher solar radiation usually get less rainfall. It must be added that the species of plants that best responded to the ecological gradients were not the species associated with pastures (the human touch), but the species found in riverine habitats and in thickets of shrub-forest which survive solely in land marginal to montados (stony uncultivated areas; quickset hedges). No matter how much the land use changes through time, these "wild" spots (outside the scope of agriculture and forestry) are a feature of the Mediterranean landscape: we believe they may act as sources of natural material for the humanised montados, keeping the "naturalness" of montados through time. As for birds, they are best considered from a landscape perspective. They did respond to several anthropogenic variables, namely the ones concerned with the density of tree cover, and the type of ground cover (agriculture or pasture; offering different diets, thus attracting different bird species). Differences in these variables are mainly due to management options, and these are not based on geographic grounds. In spite of this, we succeeded finding a geographic pattern for bird distribution across southern Portugal, a pattern that matched the plant species distribution. Our results showed that in spite of long-term human intervention in Montados, Nature keeps playing an important part in shaping this ecosystem. For policies aiming at biodiversity conservation, we believe a kind of approach that would look to specific assemblages that reflect the ecosystem as a whole would be preferable to quantifications of species richness or/and diversity indices. From our data, it looks that a montado may have a low biodiversity and still be the best possible option for a given area, in the sense that the absence of many species may be ecologically driven and not a result of mismanagement

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**Biodiversity on the Mediterranean treeline**

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On mountain areas the upper limit of the forest occupies an altitudinal belt of variable width, in which all the possible transitions between two well defined ecosystems are present, that is the forest and the high-altitude herbaceous vegetation. They are transition communities whose borders cannot be easily defined. This is an ecotone of considerable

ecological significance. With a high degree of biodiversity, it is subject to continual dynamics and is sensitive to the effects of climate change and anthropogenic impact. It extends from the limit of the forest, commonly called the "timberline", to the tree limit or "treeline". The treeline represents the border of the high tree vegetation, whose extension and composition depend on environmental conditions, among which the climatic and pedologic ones seem to be the most important. The treeline ecotonal zone represents, therefore, one of the most vulnerable systems. Slight changes in the environmental conditions, can determine considerable changes in the extremely delicate ecosystems living in this belt and consequently in the biodiversity. In fact there are mutual interactions between ecosystem stability and biodiversity changes. The role of upper treeline ecotones as indicators of environmental changes, and particularly of climatic change, is widely recognised. In many regions the timberline has been subject to change since the end of the last glaciation, with an increase in altitude with the attendant periods when the climate became warmer. It has been hypothesised that it will be subject to increases in height because of the warming of the planet that has been predicted for the years to come. The Mediterranean region is particularly susceptible to climatic change; it offers an interesting subject for studies regarding the biodiversity change, and particularly on the treeline, where some of the most delicate and vulnerable systems are present. Given that the Mediterranean treeline belt is not researched enough, there is a need to study some important aspects of this complex zone in order to be able to make hypotheses about possible changes brought about by the climatic changes that have been predicted for the planet. In particular, the state of the treeline in the present climatic conditions should be studied in order to predict possible future changes in biodiversity. This general aim could be achieved by means of a multidisciplinary research activity. The studies can be based on different research methods making it possible to deal with the subject at both a community (of plants and animals and their biodiversity) and an individual level, by means of the study of certain ecological and ecophysiological aspects and some environmental factors. This will provide significant information to predict biodiversity responses to the global changes in the climate predicted. Special attention will be devoted to search the relationship between biodiversity change and ecosystem functioning and stability. If such relations could be shown, they would be very important to provide management plans to preserve the integrity of biodiversity and ecosystem functioning, on a very vulnerable ecotonal zone like the treeline.

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**Environmental education and biodiversity conservation**

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The contribution of Dr A Drescher (23rd April) to the Restoration Ecology discussion raises issues relevant to this session. His case study of massive recent land use change on the Costa Granadina of southern Spain highlighted how agricultural innovation, largely in the form of the cultivation of early vegetables in plastic greenhouses, had resulted in a move from a long tradition of sustainable land use to a system that is rapidly polluting and exhausting both soil and water resources, and diminishing biodiversity. In a similar detailed study of the area around Nijar east of Almeria, and using satellite imagery from 1979, 1984 and 1089, I too recorded a rise in 'plasticulture' to become one of the dominant land-uses within this period. Ground-truth surveys and local interviews revealed not just the deleterious environmental consequences, particularly to the quantity and quality of aquifer water supplies, but the extent of the associated human misery. Economic instability within this new farming system was resulting in considerable crime and social deprivation, and there was anecdotal evidence of damage to the health of farm workers due to over-use of agrochemicals within hot and humid greenhouse environments. A disregard for environmental sustainability and biodiversity can have profoundly negative human implications. Socio-economic factors have been emphasised in a large number of this conference's contributions, and truly are an important consideration for a biodiversity conservation strategy for the Mediterranean region. The resulting need for a multi-disciplinary rather than exclusively nature conservationist approach has rightly been identified. One such discipline is that of environmental education, to help re-connect people to their biodiversity heritage and engender attitudes that will help value and conserve it in the future. As northern Mediterranean countries have experienced rural depopulation, and a move from land-based jobs to ones servicing tourism, such education is a replacement for the handing down through the generations of an appreciation and knowledge of natural resources, developed from working on the land. Within the work context of an urbanisation, or a plastic greenhouse, that same appreciation and knowledge can not be expected. An estuary on the Algarve coast of Portugal, a microcosm of many of the issues being discussed in this conference and a proposed Natura 2000 site, is currently serving as a backdrop to a programme of both environmental education and biodiversity research and conservation. The former aims to excite today's children (tomorrow's policy-makers?) with the diversity to be found within a Mediterranean-type ecosystem. The latter aims to understand how the current biodiversity within the terrestrial and maritime habitats present are responding to ongoing processes - for example abandonment of agricultural land (and resulting loss of habitat heterogeneity) and perturbation of fragile habitats such as coastal sand dunes - and what measures need to be introduced to maintain and enhance the biodiversity. Where the two come together is at the tertiary education level, involving students in applied research projects that contribute to our overall understanding, and at the same time help to equip the students with the skills to make further important contributions to biodiversity conservation in the future. Environmental education may not tangibly solve some of the wider questions of, for example, sustainable and economically viable agricultural systems that support biodiversity, but it can help raise the public demand and political will for such solutions. Most of all, it recognises the central importance of human values and beliefs about biodiversity, and the potential for biodiversity to enthuse and excite. Alongside applied research, policy development and practical tools, it should not be a neglected component of a biodiversity conservation strategy. Natura 2000 sites represent

opportunities to test and demonstrate how all these elements can be integrated for the conservation of European biodiversity priority species and habitats.

**Session 1 - Summary and Conclusions**

Helena Freitas - Chairwoman of Session 1, Universidade de Coimbra Portugal

During the last week of the conference, some new issues were raised and others outlined in the first week were again emphasised. I have prepared a summary of this week's contributions and drawn a few conclusions at the end. Of course, it would be very important to have further feedback from the participants, to improve the final conclusions as I may leave relevant aspects out of my analysis. I am pleased with the final result of this e-conference. I have learned a lot and I had the chance to think over my "self-confidence" concerning the strategies for conservation of Mediterranean biodiversity. It is clear that we need much more research and new methodological approaches to support the decision process and we are not going to succeed without a stronger investment in multidisciplinarity. Priority should be given to the conservation of Mediterranean biodiversity. The exceptional biodiversity of this biogeographic region is the result of a fruitful combination of ecological and cultural drivers. As J. Blondel wrote, "what makes the Mediterranean almost unique in the main biogeographic regions of the Northern Hemisphere is environmental diversity that regularly scales across local habitats, landscapes and regions. Depending on scale, the effects of environmental heterogeneity influence the composition, structure and diversity of populations, communities or the so-called metacommunities at the scale of whole landscapes. Environmental heterogeneity is particularly interesting and worth studying in the Mediterranean because it is both natural and anthropogenic." But this distinction is also the main difficulty to face when thinking of conservation of Mediterranean diversity. How to define the adequate methodologies to approach such a complex outcome of land use history, environmental constraints, and more recently, economic and policy driven management options? Conservation strategies strongly need a closer co-operation with economic and social strategies and policies. As the implementation of the Natura 2000 and supporting Agri-Environmental Policies proceeds to maintain biodiversity and traditional practices, the need for tools to evaluate the success of their application and to guide further land management and policy incentives is rising. This assessment will necessarily include ecological and social benefits.

SUMMARY (2nd week)
The landscape approach

The cultural, man-made, Mediterranean ecosystems have a very high value for conservation. But, as Teresa P. Correia emphasised, the traditional human activities that originated them are under increasing pressure in the last decades, and many ecosystems have already disappeared, or are progressively being reduced, or changed, or are at the least threatened. Mauro Agnoletti considered that the landscape perspective is effective in the management of Mediterranean ecosystems, especially when natural and human factors are considered. Landscape is the result of ecological and socio-economic processes, thus, operating within a "landscape" perspective means to take into consideration, not only ecological factors, but also the driving socio-economic forces that actually played a major role in all environmental changes. To Jose M. Garcia del Barrio, landscape is an appropriate scale for understanding and monitoring biodiversity in the Mediterranean basin because traditional human land uses have implied fragmentation and management in a fine grain. In this sense smaller administrative territorial units (e.g. municipality in Spain) are useful units for monitoring Mediterranean landscape biodiversity. Minimum administrative

territorial units are suggested because they provide population census and other socio-economic data despite being of less ecological relevance.

The loss of traditional land use practices

Axel W. Drescher used an agro ecological study carried out between 1985 and 1994 in the Mediterranean coast of Andalucia (southern Spain) to explain the effects of replacing the traditional land use pattern by market oriented agricultural practices. The destruction of the landscape by ecologically non-adapted methods of terracing steep slopes, which were formerly protected by traditional terraces is causing water management problems as the coastal plains are entirely dependent on the water resources of the Sierra Nevada and upper Alpujarra. Pere Fraga also emphasised the loss or change of traditional land uses as a threat for biological diversity, opening a way for new problems such as biological invasions.

Mediterranean islands and marine biodiversity

The need to preserve the Mediterranean marine diversity was stressed again during the second week of the conference. Simona Mihailescu showed the similarities between the Mediterranean and the Black Sea ecosystems, as a result of historical evolution, diversity of habitats and human influence. She also raised the environmental problems resulting from tourism and agriculture on the seashore (eutrophication due to agriculture, industrial activity and inputs of insufficiently treated sewage) Vlatka Scetaric & Gvido Piasevoli called our attention to the biodiversity of Croatian islands and the urgent need to care for its conservation. Rapid changes in economic activities, tourism, urbanisation, forest fires, introduction of exotic species, agricultural poisons, lack of scientific data, lack of public awareness and weakness of nature protection institutions are some of the problems threatening biodiversity in these islands.

Actions needed to preserve Mediterranean biodiversity

A strong emphasis was given to the need to develop appropriate methodologies, the need for more research and the need to promote rapid actions to preserve the unique Mediterranean biodiversity. Jesus Garcia Latorre suggested that a transdisciplinary approach in which ecological research is combined with a historical perspective of the ecosystems is essential for understanding and managing Mediterranean landscapes. He also argued that such a perspective makes doubtful the practices carried out by the public administration in the framework of its programs for Nature protection and management. He suggests the recreation of some of the activities traditionally carried out; like keeping some livestock, controlled fires. Tor-Björn Larsson, also argued that it is difficult to conserve elements of biodiversity that have developed because of traditional land-use without preserving that land-use too. To Clare Tenner & Steve Alton, the complex threats facing Mediterranean biodiversity are likely to require complementary approaches to conservation. Ex-situ conservation, seed banks, can play a key role in ensuring the protection of plant species.

## CONCLUSIONS

1. Biodiversity in Mediterranean landscapes is closely related with cultural diversity (Zev Naveh's ecodiversity concept). Conservation of Mediterranean ecosystems requires a comprehensive study and conservation management of Mediterranean landscapes, and a close co-operation of scientists from natural sciences and from the social sciences and humanities.

2. Mediterranean landscapes have undergone major land use changes in the last decades, as a result of rapid technological, economic and social changes. The loss of traditional land use practises was pointed out several times as a main threat to the Mediterranean biological diversity. An assessment of vulnerability of these ecosystems to future land use change is thus fundamental. Scenarios for future land use, combining the compilation of historical data, climate, constraints by regional socio-economical scenarios and the natural context are urgently needed.

3. It is essential to understand the effect of landscape changes to the dynamics of biodiversity in relation to the functioning of terrestrial ecosystems across successional stages.

4. Non-indigenous species are widespread in the Mediterranean and threaten marine, freshwater and terrestrial ecosystems. Current legislation covers non-indigenous species but is not sufficiently comprehensive. Comprehensive legislative instruments have to be developed.

5. The Mediterranean biodiversity conservation should be included in priority global biodiversity conservation programs and sustainable development be taken into account, specifically in the fields of tourism and agriculture.

6. Biodiversity protection should be included in local and regional land development policies and a network of terrestrial and marine protected areas should be created, to optimise long-term conservation of biodiversity in the Mediterranean region.

# Session 2; Restoration Ecology

## Introduction to Session 2

José M. Rey-Benayas - University of Alcalá, Alcalá de Henares, Spain

Restoration ecology aims to recover the structure and function of ecosystems that have lost it, usually by human activities, which are noticeable at local, regional, and global scales. At the global scale, approximately 40% of the net productivity of terrestrial ecosystems is in one way or another used by people, and nearly 50% of the land surface has been converted into cropland or semi-natural grasslands; human activities release more nitrogen than the natural physical, chemical and biological processes; and ca. 10% of the 41.000 km3 of water that move annually through the hydrological cycle are stocked in reservoirs. At the more regional scale, the official statistics of the European Union show that less than 2% of the original extension of natural and semi-natural forests remains in the EU Mediterranean countries.

These examples constitute a two-faced coin: much has been lost or degraded, thus much needs to be done for rebuilding it, at least partially. Restoration ecology is certainly an emerging scientific discipline. In the Biological Abstracts electronic database the search for "restoration + ecosystem or habitat" renders an increasing number of scientific publications in recent years: 72 references in 1995, 159 in 1997, 450 in 1999, and 673 in 2001.

The reconstruction of original ecosystems is usually difficult, expensive, and ideally requires multidisciplinary teams. In my view, the main challenges of restoration ecology are related to these issues. It must be able 1) to develop a theoretical framework to define objectives of ecosystem reconstruction and set priorities of ecosystem types and sites to be restored, 2) to optimise the investment/benefit ratio – note that to accomplish this objective it is necessary to have effective monitoring of restoration, and 3) to assemble multidisciplinary teams of experts in fields such as conservation biology, pollution, environmental impact mitigation, revegetation, sustainable use, natural resource management, economics and law.

Within the theme of this conference there are many topics that need to be discussed – the aims of restoration ecology, setting priorities for ecosystem restoration, designing regional vegetation cover, habitat restoration for animal populations, plant conservation ecology, restoration of agricultural landscapes, wetland restoration, soil rehabilitation, mine and constructed sites reclamation, sustainable development of restored habitats and economics of restoration ecology, just to name a few.

Let me end this text with four questions. Considering that an ideal ecosystem restoration is most often impossible to achieve:

1) Do you suggest a more practical definition for restoration ecology?
2) How do we rank priorities?
3) How could we measure the benefits of ecological restoration?
4) Are the above-mentioned multidisciplinary teams feasible at all?

The two weeks of discussion that we have ahead of us hopefully will shed light into some of these questions. I encourage you to participate and share your experiences on these and related topics.

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**Goals for Ecosystem Restoration: An Example from Coastal Sage Scrub, Southern California**

Edith B. Allen - Department of Botany and Plant Sciences, University of California, Riverside, California, USA

The coastal sage scrub (CSS) of southern California has undergone extensive restoration efforts because of impacts from agriculture and urbanization that have destroyed natural vegetation, but also because remnant stands are subject to invasion by Mediterranean annual grasses and nitrogen deposition from automobile exhaust. The overall goal for restoration is generally to return the ecosystem to some semblance of its former structure and functioning prior to disturbance. The kinds of disturbances that an ecosystem receives in part determine the limits to restoration. Multiple anthropogenic disturbances impact CSS, including historic grazing that may have dispersed seeds of exotic species, frequent fire, urbanization, fragmentation, as well as anthropogenic N deposition. These have all led to an increase in annual invasives and a decrease in native shrubs and understory forbs. Shrub mortality is high in CSS stands adjacent to urban areas, which have averaged 90% loss of shrub cover.

Often restorationists hope that removing the disturbance that impacted the ecosystem will lead to natural recovery by succession, which may be termed passive restoration. Alternatively, the more intensive management of active restoration includes soil management and reintroduction of propagules, or removal of undesirable species, and is done only when passive restoration fails, or when natural succession is too slow. Thus restoration requires an ecosystem approach including management of soil nutrients, microorganisms, plants, and animals.

Observations of natural succession in southern California show that the pervasive exotics will not decline during succession. In one study CSS and chaparral sites varying in age from 2-71 years did not have an increase in native shrub cover with increasing time since disturbance. The study indicates that natural successional processes will not return this vegetation to its original composition, so restoration is needed if a return to native shrubland is the goal.

Reestablishing the original biodiversity is one of the major goals of many restoration projects, while at the same time it is one of the major limits to restoration. Restorationists often take advantage of colonizing or seedbank species to increase diversity, as it is often impossible to replant all of the prior diversity. An example from CSS comes from roadside restoration, where no more than 15 native species recolonized the oldest sites. In this case the soil had no seedbank, as topsoil was not used. The colonized sites were close to adjacent native vegetation, while sites adjacent to urban landscapes had little or no recolonization. This suggests that the location of a restoration site in the landscape will have a large effect on the success of the restoration project.

The problem of elevated soil N from atmospheric deposition creates another set of problems and limitations for restoration. Elevated soil N will increase weed productivity over that of native species, so restoration may require reducing soil N and controlling weeds. Mulch may be used for the former, as the added organic matter will cause immobilization of N by soil microorganisms. When the N is not available to exotics, native plants may establish more successfully. A study in disturbed CSS showed that immobilization of N by bark mulch promoted a higher density and growth of native Artemisia californica compared to straw mulch or unmulched plots. The overriding principle is that soil nutrients need to be adjusted to meet the needs of the native species that are established. In some parts of the world this may require fertilization, but soil eutrophication by N has also become a global problem.

Mulch may be used on a small scale to reduce soil N and promote growth of native species, but on a large scale other methods have been employed to control Mediterranean annual grasses. These include fire, mowing, grazing, dethatching, and grass specific herbicide. Fire may be used in spring to destroy next season's weed seed bank, a technique that has been successful in restoring California perennial grasslands. However, in shrublands, spring burns are slow to recover, so fire has not been recommended as a tool where remnant shrubs are to be protected from damage. Dethatching or lightly raking exotic grass litter has promoted germination from the native seedbank, a method that deserves further examination. Grass-specific herbicide and sheep grazing were both effective in removing grasses, but had the side effect of promoting exotic annual forbs (Erodium spp.). However, stands of Erodium were not as competitive as stands of annual grass against seeded native species, so herbicide and grazing may ultimately be useful approaches.

Since CSS is a fire-adapted vegetation type with a historic 30-year fire cycle, removing the fine grass fuel and replacing it with native shrubs and forbs is ultimately the goal for restoration. Once grass invades the CSS, it becomes more subject to fire, and fire cycles of 5 years have become common in remnant fragments near urban areas. No restored sites old enough to burn occur at this time, but ultimately the real test of our ability to restore CSS will be if it can be burned, and then recover naturally.

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**The role of scientists in restoration ecology**

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I have read the introductory notes sent by the general organizers and the two chair-persons of our e-conference. At this time I only want to send you my reaction to a number of topics in their messages, aiming to provoke additional reflections and discussion.

I attempt to make my contribution from the perspective of a professional academic ecologist, who has a long-term interest in attaining a meeting of goals by practicing ecological science and looking for its feasible applications for mitigation and restoration of human-induced patterns and processes.

1. I am not completely convinced that restoration ecology may be such a novel emergent field of academic and outreach activity, as we have been so frequently told over the last 10-15 years. Actually, I believe that it may not be particularly helpful, and may be even contradictory, to insist in such originality and in what can be perceived as its granted

exclusiveness on the side of ecologists. This may not be a novel bias. For those of us who obtained our academic degrees three or four decades ago in centres of ecological research, it was not surprising as incoming graduate students to find general agreement about how far from applications the cutting-edge of ecological science was. Of course, there were some notable exceptions; but that they were: exceptions, not the most common case. At that time, terrestrial ecologists were trained mostly divorced from activities in such long-developed applied fields as forestry, range and wildlife management, and agronomy. Consequently, most ecologists used to practice a rather capriciously-defined, taxa-oriented, pristine-habitat research that would have little concern with human impacts. Actually, just as an example, notwithstanding the current appreciation of natural disturbance as a major ecological factor of ecosystem functioning, it appears that human impact has still a long way ahead towards its full recognition by academic ecologists as a similar force structuring our surrounding nature.

2. The worldwide ecological community has ever since made much progress on these issues, and in others that you might consider quite more substantial. Yet, I can see that we frequently remain largely unaware of developments, traditions, and well-established practice in applied fields related to our recent interest in ecosystem restoration and impact mitigation, as those I mentioned above. A notable exception of recent productive exchange may be the hybrid field of agroecology, where ecologists and agronomists (but also a few foresters and economists) are building a common field of scientific enquiry and technological development. I do not seem to find a similarly rich and open sharing of experiences with foresters and professionals in other fields dealing with natural resources management. Sometimes, they may seem to be too pragmatic, market-oriented, even rather sloppy; on the other hand, ecologists may frequently be considered as too theoretical, and so much slow-paced, and even naïve, to face and satisfy the real needs of people that we work with in ecological restoration programs. However, there are already many relevant advances, and well-established and valid approaches in applied fields, directly relevant to ecological restoration and landscape ecology, that we do not have to reinvent by ourselves again from scratch.

3. We are being told (and I completely agree) that ecosystem restoration may require the participation of multidisciplinary teams. What it will constitute such a diverse team, and will make it to work properly to meet its goals? I can see, at least, that its structure and functioning should be founded on wide perspectives and ample recognition of the potential contributions from the participating fields of expertise. But we cannot take this for granted. We should put our effort in enriching (and thus gaining time) the "melting pot" with our particular strengths. For example, I would think that ecology has much to contribute with relevant theory and detailed methodologies for adequate data gathering, analysis and interpretation. As a counter example, I suspect that ecologists are hardly qualified to do a better job in running production-oriented orchards or plantations than agronomists and foresters. It seems that we should put time and effort in defining those fields of expertise within the group where we can function optimally.

4. Are we behaving optimally? Probably not. And not because we had concluded that this behaviour could be inadequate. I believe we should discuss these issues more thoroughly for a while to act accordingly. A major front for advance lies in the design, development and running of programs of graduate study. I still find difficult to identify truly multidisciplinary programs of study related to natural resource management. It seems rather

common that a major field tends to dominate the program, being either ecology, or economics, or rural sociology, or rural planning, forestry, and so on. I would particularly insist in inviting to this forum new students approaching ecological restoration. I would insist in both resting on the long established foundations of relevant fields of expertise, and in commonly defining a shared cutting-edge for the development of our emergent scientific and technological discipline.

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**Evaluation of extinction risks and re-introduction of plant species in a fragmented Europe**

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Understanding how animal and plant populations respond to environmental disturbance plays a central role in conservation biology. A direct consequence of human-induced disturbances in terrestrial ecosystems is habitat fragmentation following changes in land use. Drastic changes in population size and/or degree of isolation may dramatically increase population extinction probabilities. In fact, threatened species have dispersal problems in fragmented habitats, and remnant populations become too small and dispersed to persist over time and/or re-colonize suitable new habitats. For this reason, accurate demographic and genetic characteristics of fragmented populations at different spatial scales become an essential knowledge to perform realistic conservation programs.

TRANSPLANT, an EC project focusing on the estimation of extinction risks and re-introduction of fragmented plant populations in Europe, aims to (1) understand the effects of habitat fragmentation on the survival of plant species, and (2) to develop sound guidelines for active species-level restoration measures, including re-introduction and taking into account the genetic, demographic, and landscape-level risks involved. To this end, breeding experiments quantify the effects of genetic diversity on persistence and dispersal, molecular markers estimate gene flow between populations, demographic models assess population extinction probabilities, sowing and transplanting experiments measure local adaptation, and several other experiments determine dispersal capacities and regeneration strategies of plant species. This information will be integrated into a GIS model to provide the basis for an estimation of changes over time in the number and size of plant populations. Study plant species fulfill a longevity-dispersability matrix. Thus, short- and long-lived plant species with good and bad dispersal capabilities have been selected to allow a wider generalization of conclusions. Based on this knowledge, risk evaluation tools and restoration/re-introduction rules will be developed to improve our conservation capacity, allow the sustainable use of plant biodiversity, and reconcile economic development with the protection of threatened plant species. Although the project addresses conservation problems in fragmented dry grasslands of north and central Europe (United Kingdom, Sweden, The Netherlands, Germany, and Czech Republic), resulting conservation strategies can contribute to the conservation and restoration of any habitat affected by progressive fragmentation.

A better understanding of the role of fragmentation for the extinction risks of plants on a European scale will help to critically evaluate national red-data lists and integrate these into a wider framework. Furthermore, it will be possible to better assess the environmental impact of European scale developments in agriculture, transport and industrial

developments that affect the degree of landscape fragmentation. Results will be widely disseminated in order to contribute to future EC policies on biodiversity conservation, as several EC directives and programs dealing with conservation are demanding such actions.

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**Is Restoration Ecology restricted to certain scenarios?**

Luis Balaguer - Dept. Biología Vegetal. Facultad de Biología, Universidad Complutense de Madrid, E-28040, Madrid, Spain.

As Dr. Gonzalez-Espinosa has stated in this e-conference, Restoration Ecology is not such a recent discipline (at least several decades, Cairns & Heckman, 1996). Its main aim has been clearly posed by the Chairman and by Dr. Allen, that is, to recover the structure and function of ecosystems. Despite the underlying scientific challenge, most restoration projects have been designed not by scientists but by technologists or environmental managers.

Perhaps due to this fact, most projects associated with civil and mining works have imported their basic criteria from agronomic engineering, not from ecology. In these projects, the quality is measured in terms of depth of added topsoil, substrate nitrogen content and percent plant cover reached by the programmed seedlings. In all of these criteria the rule is 'the more the better', even when it implies the divergence from the features of the target ecosystem.

Some scientist could claim that these sort of projects are out of the scope of Restoration Ecology, and consequently should be alternatively labelled as reclamation, reforestation, revegetation, rehabilitation… However, they represent the vast majority both in number and in land surface affected. It might be revealing just to quote that the area that should be restored in the coal mine located in As Pontes in North-western Spain is larger than a whole National Park, such as Las Tablas de Daimiel in Central Spain, or that the density of main roads alone in The Netherlands is 1.5 km/ km2.

It could also be claimed that these scenarios lack ecological relevance and thus are not scientifically challenging, being routinely sorted out just using standard protocols. This is obviously not the case. The ecological complexity of these projects can be easily envisaged considering the environmental heterogeneity intersected by any medium-size road or its dual role as corridor/barrier or the conservation value of roadside native-plant communities. Australia has created a huge network of road- reserves to preserve native vegetation (see Forman & Alexander, 1998).

Deficient project objectives in areas affected by civil works can not be justified. Even those projects whose goal is strictly ecosystem restoration and are restricted to natural protected areas rarely escape from this requirement. In scientifically-supported projects, success has been often measured by the capability of maintaining numbers in bird populations and bird breeding efficiency. Some recent rigorous projects for marsh restoration have even considered the possibility of feeding ducks to gain a wider social acknowledgement. Environmental education activities and ecological restoration projects are often linked to some extent.

In my opinion, there is not a single reasonable reason to restrict Restoration Ecology to its role as a conservation tool within the framework of protected natural areas, while most of

our immediate environment is being ruined by using erroneous restoration protocols. Multiplication of different names to segregate restoration practices might be hiding our inability to identify the basic principles that must share any project regardless of the scenario chosen.

In my opinion, besides the decision framework for selection among choices in restoration projects (Wyant et al. 1995; Whisenant, 1999) there are three key factors to ensure quality:
1. Origin of the plant material
2. Synergism between environmental heterogeneity and connectivity
3. Management of the original topsoil as a diaspore bank

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**Restoration ecology**

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Restoration ecology must be approached by multidisciplinary teams. General scientists and ecologists in particular are as qualified as agronomists or forest engineers to works in restoration ecology and are experts on zoology, phytosociology and other subjects that are fundamental to ecosystems restoration. I completely agree that ecological restoration projects require multidisciplinary teams. If the objective is to restore an ecosystem, it unquestionably involves counting on ecologists knowledge. In the present circumstances in Spain, scientists make science and engineers resolve technological problems using applied science. This traditional discriminatory behaviour has been strengthened by agronomist or forester professional associations to extend their corporative and labour market. Judges have passed sentence against this position, so any qualified professionals may work in restoration and environmental impact assessment. I want emphasize that scientists, are perfectly qualified and have to play an important role in restoration ecology as well as be experts on subjects like ecology, zoology or phytosociology (biologists) and geomorphology or slope stability (geologists) . Lastly, I wish to emphasize that the dichotomy between scientists and engineers in Spanish society must change to be the same as in other countries, and scientists must be seen like other professionals qualified to work in this kind of project. Also University study programs must be changed to adapt them to society needs and labour market.

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**Restoration Ecology**

Beata Woziwoda - University of Lodz, Poland

I agree with Luis Balaquer and Mario Gonzales, that restoration ecology is not a new discipline. In our study we look for ways of natural (passive) or human (active) restoration of natural ecosystems changed by human activities. Active restoration ecology exists in natural parks and nature reserves as active conservation. The human activity is needed if a return to native communities, with original structure and species composition, is the goal and if the main subject of nature conservation can't exist without active (human) intervention. The restoration of vegetation we must undertake very carefully, with complete knowledge about all processes connected with changes of plant cover and ecosystem. Do we have this knowledge now? I don't think so.

In many case we observe, that the results of active restoration are worse than results of natural succession, and sometimes they lead to more destroyed structure and composition of community. We have a lot of examples of inappropriate forest vegetation protection (because of forest protection works). The huge scope and scale of current anthropogenic transformations of nature compel us to activity which will stop destruction and threats, and will make possible a reconstruction of destroyed ecosystems. In recent decades scientists have tried to accelerate the reconstruction of natural vegetation. The restoration ecology we can call experimental restoration ecology. This part of ecology, of natural sciences will develop. This term exists, and even we have opportunity to use it, it will still exist. The problem is, if it will make more order of ecological sciences or just the opposite. (?)

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**Reply to Restoration ecology**

Emil Ivanov - European Youth Forest Action, Bulgaria - Netherlands

I believe also that the continuing mainstream reductionist striving to detach the issue from the complex situation, define it nicely and then when try to apply or deal with it, the result is rather unsatisfactory. Holistic, interdisciplinary, integrating and adaptive approaches, combining science, policy and management, are necessary in order to overcome our failures for larger scale environmental improvement. This implies influencing and changing the current functioning of authorities and institutions, not only the ones which directly deal with the environment, but mostly those which often do not know - say what exactly is biodiversity, and which also often impose the major impact on it. As far as I know adaptive management has been well implemented in Canada and the Pacific North-west of the USA, but I haven’t heard of it being applied in the Mediterranean region at all. I wonder whether it is popular at all. I have noticed that adaptive ecosystem management is mentioned in the CBD agenda. It should be widely applied everywhere, so some preliminary academic projects regarding this field would be quite beneficial.

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**Soil rehabilitation in Mediterranean ecosystems**

Rob Marrs - Applied vegetation Dynamics Laboratory, University of Liverpool, Liverpool L69 3GS, UK. calluna@liv.ac.uk

The Convention on Biological Diversity (CBD) has adopted the ecosystem approach as the primary framework for conservation. To implement this in any ecosystem, it is essential to maintain soil integrity, because it is the soil matrix that provides plants with water and the entire ecosystem with essential nutrients.

Mediterranean ecosystems are under threat from a wide variety of threats that can be broadly grouped into three with respect to impacts on soil: (1) biotic factors (overgrazing, fire, human), (2) climate change (higher temperatures, reduced annual rainfall but increased storms), and (3) intense disturbance which is often derived from the other two. Clearly all of these factors interact on soils, and are intensified on steep slopes, where there can be wholesale erosion. Ecological degradation from whatever source starts with reduced vegetation cover and plant diversity, increased gaps, leading to increased soil microbial activity1, increased leaching losses and then as the soil surface becomes increasingly bare, particulate erosion. This leads to complete loss of soil integrity. Conservation of a vegetation-soil continuum with all processes intact is the key to the prevention of degradation. This will maintain a high organic matter content with a high organic nutrient store and will help conserve moisture. Where the vegetation cover is maintained erosion will be reduced. Lesson number 1: If it works don't let it get broken. Once degradation is advanced a hysteresis may be invoked which is much harder to repair – processes are lost and they need to be re-established and this is much harder. Here, the system may be left almost desert-like and the system is similar to a true primary succession on raw materials2. Here the main problem is to re-establish all soil processes, especially nitrogen cycling2. In a really severe case ecological restoration might need to involve: restructuring land forms to reduce erosion using bulldozers or dynamite, the addition of organic matter to help build an organic soil pool (good use for sewage sludge) which helps to increase moisture retention capacity, and the inclusion of legumes or other non-fixing species – with their symbionts, to help develop a nitrogen cycle. Lesson number 2: If it is really badly degraded then restoration of anything is possible but it takes longer and costs an awful lot more.

It seems to me that the current biotic pressures facing Mediterranean ecosystems coupled with the likely impact of climate change which will increase existing damage can only be mitigated in three ways: (1) an acceptance of increased desertification in areas with a Mediterranean climate – no action other than a socio-political one is required, (2) a positive attempt to maintain high quality habitat over as wide an area as possible to help maintain soil integrity through natural processes, or (3) an acceptance that damage will occur and large scale-restoration will need to be implemented and funded. Irrespective a good knowledge of the resource base is needed through the production of "soils at risk" maps for Mediterranean areas. Experimental work is also needed to make sure there are contingency plans for soil rehabilitation is inadvertent damage occurs under (2).

These are the challenges!

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**Session 2 - Summary of the 1st week of E-conference**

José M. Rey-Benayas - University of Alcalá, Alcalá de Henares, Spain

We had the opportunity to read seven interesting contributions besides the Introduction to the Ecosystem restoration session of the electronic conference on Scientific responses to threats in Mediterranean Ecosystems: conservation, mitigation and restoration. I am happy that this pool of contributions has been posed by a variety of scientists (plant biologists, ecosystem ecologists, ecoagronomists) and technicians (civil engineers) from different countries. From these contributions, I see some common claims and concerns pertaining to the field of Restoration Ecology that I outline below.

1 -The myth of Restoration Ecology as a new discipline. Some participants (Luis Balaguer, Mario González) agree with the issue that Restoration Ecology per se is not a new discipline. Actually, it sounds as a relatively new discipline for the ecologist guild, in spite of it has been addressed by guilds such as agronomists and foresters since a few decades ago!

2 - What should then be the major contribution of ecologists to this "emergent" field? Different authors insist on the necessity that ecologists build up a conceptual framework of the objectives, methods, and evaluation of Restoration Ecology. On top of this, they (us) have the responsibility of pursuing a more synthetic, holistic approach of ecological restoration as opposed to the current dominant "technological and engineering" approach. Technology is useful, and often pertinent, to solve restoration problems. However, the issue of rebuilding the structure and function of ecosystems that translates into services to humankind must be always present.

3 - Items 1 and 2 directly lead to the major consensus of all contributions. Ruben Álvarez, Luis Balaguer, Emil Ivanov, Mario González and myself claim that restoration projects should involve multidisciplinary teams including a variety of basic and applied scientists and engineers. We are far from reaching this target. Actually, there seems to be an stupid "divorce" or dichotomy between scientists and engineers. Again, it is the responsibility of all of us to reach a common language as an starting point.

4 - Two authors, F. Xavier Pico and Rob Marrs, dives on the importance of "basic science" to meet the goals of ecological restoration. Pico summarises the European Union TRANSPLANT project that "aims to (1) understand the effects of habitat fragmentation on the survival of plant species, and (2) to develop sound guidelines for active species-level restoration measures, including re-introduction and taking into account the genetic, demographic, and landscape-level risks involved". Marrs explains the problem of soil rehabilitation in Mediterranean ecosystems, and claims that "experimental work is also needed to make sure there are contingency plans for soil rehabilitation if inadvertent damage occurs under attempts to maintain soil integrity through natural processes".

5 - ¿Passive restoration or active restoration? "Often restorationists hope that removing the disturbance that impacted the ecosystem will lead to natural recovery by succession, which may be termed passive restoration", whereas an study in the coastal sage scrub of southern California "indicates that natural successional processes will not return this vegetation to its original composition, so restoration is needed if a return to native shrubland is the goal" (both sentences are literally extracted from Edith Allen´s contribution). Further, Emil

Ivanov believes "that adaptive management is an appropriate approach, which could be applied in any case, involving ecosystem protection, restoration or sustainable management", and Rob Marrs considers that "existing soil damage can only be mitigated in three ways: (1) an acceptance of increased desertification in areas with a Mediterranean climate - no action other than a socio-political one is required, (2) a positive attempt to maintain high quality habitat over as wide an area as possible, or (3) an acceptance that damage will occur and large scale-restoration will need to be implemented and funded".

We are just starting to scratch the issue of Restoration Ecology, its possibilities and limitations.

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**Impacts of agricultural innovation and transformation of the mountainous hinterland in the Mediterranean - an example from southern Spain (Costa Granadina)**

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Main results are: The traditional land use pattern was replaced by market oriented agricultural practises. The changes in land use patterns occurred very quickly starting in the early eighty's, not reaching their peak up to now. The main feature of the development is the destruction of the landscape by ecologically non - adapted methods of terracing steep slopes, which were formerly protected by traditional terraces. Heterogeneous development of the higher Alpujarra and the coastal plains with respect to the emigration and immigration pattern is threatening the interaction between both areas, especially the water management. The coastal plains are entirely dependent on the water resources of the Sierra Nevada and upper Alpujarra. Dry land farming has been abandoned nearly completely.

The Vega of Motril and the mountainous hinterland are subject to changes in different ways. In both areas tropical and subtropical fruit trees are established. In the plain, sugar cane and potato are replaced by these new cash crops, while in the hinterland, mainly traditional groves of almonds and olives are affected. Additionally the foothills are transformed for the establishment of plastic greenhouses (invernaderos) for early vegetable gardening (cultívos extratempranos). These measures cause heavy erosion and destruction of large parts of the natural vegetation (monte bajo) and led to a "sterilisation effect" of the landscape and the over exploitation of the natural water resources. Thus, the functional capacity of the regions of the Mediterranean coast is jeopardised, bearing in mind the natural sensitivity of the coastal ecosystems: they are also submitted to additional burdens, caused by different anthropogenic factors.

The wide range of uses of these regions induces additional burdens. An erroneous use, or one not adapted to the environment, damages these systems, often in an irreversible way. Highland - lowland interactions especially get more and more focused on, with respect to the management of Mediterranean ecosystems, e.g. in the case of the Sierra Nevada in Southern Spain. Water management and soil conservation are highly dependent on a sound functioning of these interrelationships. Recent developments in the greenhouse areas show increasing problems with pest management as result of the landscape management. High residues of pesticides in soils and agricultural produce are one consequence. Future

sustainability can only be obtained through a change in agricultural management. Measures are needed to design a more sustainable way of land use in the future.

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**Why is restoration ecology a major issue today?**

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I was surprised to read that restoration ecology is described as scientific research. I have learned that scientific research makes use of experiments and that a scientific finding is defined on the fact that a certain experiment can be repeated over and over again with the same result. I have never seen an ecological restoration experiment giving the same result twice. So I conclude that ecological restoration is NOT a scientific discipline. It is a management option, if not a political choice!

Things are different when we speak about the processes involved in ecological restoration, these are aspects of science. A serious ecological restoration project should make use of all existing knowledge. This is good practice. Making use of all existing knowledge makes the project multi-disciplinary. And lets be honest: most ecological restoration, if not most ecological projects today are multi-disciplinary. What those projects need is trans-disciplinary research. This is however very rare practice because you do not only expect scientists of different disciplines to work together but also to speak, and more, to think together.

It is not only the ecologists and the engineers that do not speak with each other. Put scientists of different disciplines together and, most of the time, you have the same problem. Most of the time, efforts are done, especially by funding agencies, to bring them together, but they do not speak each other's language. During the past ten years a lot of money has been used to teach common language. However, this has mainly failed. Much more important is to find translators: people capable of transferring knowledge from one discipline to the other. This is not the task of the common scientist but of specialised communication people. Much more money should be spent in science communication!!!! Not only towards other scientific disciplines but also to the public.

Why is restoration ecology a major issue today? Because politicians like the positive terminology: they are going to restore something that is valuable. This sounds positive in the ears of the future voters. At the same time they do not act on the real environmental problems causing the destruction of similar habitats (sometimes very close to the restoration site). This would require political courage because the general population does not always like environmentally friendly measures.

You could bring scientists of a multitude of disciplines together to discuss restoration as a scientific response to threats in the Mediterranean. But would it not be more interesting to bring together political leaders from the Mediterranean region to discuss a political response to those threats. This is only possible when scientists speak with one voice, when your public is informed on causes and consequences,... What we really need is SCIENCE COMMUNICATION.

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**Why is restoration ecology a major issue today? A reply**

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I was surprised to read the contribution from Dr. Jurgen Tack arguing against the use of scientific methodology within the overall restoration process.

I have no worries at all with the gist of his message that communication is needed both between scientific disciplines and with other professionals to provide informed responses for the general public. Ultimately restoration in its widest sense will either be developed either through political or fiscal means. I also agree that the restoration process involves multi-disciplinary teams, including engineers, socio-economists etc, - this is crucial to the successful implementation of good restoration practice.

However, the cornerstone of the methods for restoration ecology (i.e. developing or managing ecosystems) must be based on sound ecological science. There are so many examples of this that it hardly needs to be reiterated (e.g. Bradshaw 1983). The comments in Tack's paper on scientific methodology are, in my opinion, not only wrong but downright dangerous. His quote "I have learned that scientific research makes use of experiments and that a scientific finding is defined on the fact that a certain experiment can be repeated over and over again with the same result I have never seen an ecological restoration experiment giving the same result twice. So I conclude that ecological restoration is NOT a scientific discipline.". This is evidently not true, because the general

principles derived from ecological restoration experiments have been used to guide restoration in many cases.

Moreover, ecological experimentation must be considered within the context that the experiment is done - almost all such experiments have a high variation and some factors are outside the experimenter's control. There is nothing new here; this is exactly the scenarios that skilled ecologists (and their subset Restoration ecologists) use to develop principles and guidelines to help implement restoration policy in new situations (see Bradshaw 1983).

Reference

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**Restoring Natural Capital in Mediterranean Ecosystems and Landscapes**

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Restoration ecology (RE) is not a 'new' field or discipline, but it (and the Society for Ecological Restoration) is now in a phase of expansion and internationalisation, such that a brief summary of recent trends may be useful. Most 'generation-1' literature and actions in RE (1975-1999) focussed on the recovery of populations, communities and, more rarely, ecosystems - with "integrity" or "authenticity", and on related biodiversity issues such as the control of exotics, re-introduction of endangered species, or the re-establishment of species-rich herbaceous communities in former agricultural land. In practice, however, especially in the United States, it was compliance to federal regulations concerning "mitigation" or "replacement" that was paramount.

The 'second generation', like some unpublicised practitioners of generation 1, will likely focus on Restoring Natural Capital (Clewell, 2000), the obvious but long neglected meeting ground for ecology and economics, community groups and public policy. "Natural capital can be viewed as the sum total of ecological systems that support life, different from human-made capital in that natural capital cannot be produced by human activity" (Hawken et al.,1999: 151).

Like RE, the notion of Natural Capital is not brand new (e.g. Jurdant et al., 1977). Alongside "economic capital", and "cultural capital" (Farina, 2000), "natural capital" (NatCap) now needs to become prominent in public debate and in environmental education. Not only is NatCap the fundamental basis for every economy and society, but also it may be increased by ecological restoration, while benefiting economies at the same. In all events, RNC is a concept that should greatly facilitate the integration of ecology and economics while also contributing to the sound management, conservation and conceivably the improvement of the biologically-rich and economically valuable, cultural, semi-cultural or natural landscapes and ecosystems of the Mediterranean region, as elsewhere. Enrique Hernandez Laguna's contribution to the E Conference (19.04.02) is highly pertinent in this regard, and calls for more discussion and response. Economists' indices of economic

growth need to be modified (Arrow et al., 1995), so that the flow of ecosystem services as well as the value of net stocks of natural capital, the high cost of repairing damaged ecosystem functions and services, and other social or cultural costs related to RE and conservation can be internalized. The Restoring Natural Capital focus is based on the affirmation that intact ecosystems and landscapes, both natural and cultural, provide needed goods services for less cost than manufactured goods and engineered services. Intact, healthy ecosystems, it is argued, need less management and subsidies than do any other, purely engineered systems (agriculture, agroforestry, tree farming, etc.) or those which have been damaged and now require repair. Finally, they are vital to human health, at population, community and all higher levels (Aronson & Le Floc'h, 2000).

In the multi-faceted, biological and cultural 'hot spot' Mediterranean region, we must begin to carry out evaluations, estimations, predictive modelling and large scale, long-term experiments, using combined ecological and economics tools and metrics, so that a RNC approach can be cultivated for application to emerging ecological economics and public policy forums.

References

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- Hawken, P., Lovins, A. & Lovins, L. H. 1999. Natural Capitalism. Little, Brown and CO., Boston, USA.
- Jurdant, M., Bélair, J.L., Gerardin, V. & Ducroc, J.P.1977. L'Inventaire du Capital-Nature. Méthode de classification et de cartographie écologique du territoire. Service des Etudes Ecologiques Regionales, Direction Regionale des Terres, Pêches et Environnement, Québec.

ANNEX
(Based on the SER's Science and Policy Working Group's Efforts, which will appear on the SER website in the next few weeks).

As a complement to the informal definition of ER offered by José M. Rey Benayas at the start of this E-Conference, the SER's Science and Policy Working Group now proposes:

Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed. It is intended to repair those ecosystems with respect to their health, integrity, and self-sustainability (Source: a Primer on ER to be posted shortly on the SER website, www.ser.org).
Further, ecological restoration can be conducted at a wide variety of scales, but in practice all ecosystem restoration should be approached with a spatially explicit landscape perspective, in order to ensure the suitability of flows, interactions and exchanges with contiguous ecosystems. An ecosystem can be recognized in a spatial unit of any size, from a microsite containing only a few individuals to an area showing some degree of structural

and taxonomic homogeneity such as a small-scale and community-based "wetland ecosystem," or a large-scale and biome-based "tropical rainforest ecosystem."

A landscape consists of a mosaic of two or more ecosystems that exchange organisms, energy, water and nutrients. A legitimate and indeed important object of much ecological restoration is the reintegration of fragmented ecosystems and landscapes, rather than focusing on just a single ecosystem. A natural landscape or ecosystem is one that developed by natural processes and that is self-organizing and self-maintaining. A cultural landscape or ecosystem is one that has developed under the joint influence of natural processes and human-imposed organization.

Zev Naveh (17.04.02) is of course right to emphasize the landscape level of integration and resolution in the Mediterranean region. Nonetheless, ecosystem remains a valuable term and frame of reference for ER and RE, if and when it is used in conjunction with landscape in a hierarchically explicit framework.

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**Re-introduction/restoration work in threatened species of plants and animals.**

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Increasingly the pressure on landscape use and population fragmentation of the type described by F. Xavier Pico in his contribution on ' Evaluation of extinction risks and re-introduction of plant species in a fragmented Europe' is requiring the movement and release of animals and plants. This can be as a single-species conservation action, part of a multi-species habitat restoration programme or as mitigation movements in the light of impending habitat alteration or destruction. In all cases the processes involved are complex and the protocols used require careful consideration.

The Re-introduction Specialist Group of the IUCN SSC exists to provide clear guidance to projects involved in these sorts of activities and has already produced general 'Guidelines for Reintroduction', which became official IUCN policy in 1995 and were published in booklet form in six languages in 1998. The group is also increasingly involved in producing taxon and circumstance specific guidelines. The group is structured through a series of sections, each with a chairperson covering different taxa and regions of the world and is keen to be informed and involved in initiatives involving plant and animal movements in the Mediterranean ecosystem, or specific projects addressing protocols.

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**Session 2 - Summary and Conclusions of E-conference**

José M. Rey Benayas (Chairman) - University of Alcalá, Alcalá de Henares, Spain

Thirteen interesting contributions have been posed to the Ecosystem Restoration session of the electronic conference on Scientific responses to threats in Mediterranean Ecosystems: conservation, mitigation and restoration. I am grateful and indebted to the conservation biologists, plant ecologists, landscape ecologists, ecosystem ecologists, ecoagronomists, and civil engineers for their contributions. They are named throughout this text. In my first-week summary I outlined five claims and concerns pertaining to the field of Restoration Ecology (items 1-6 below, note that I split former item 4 into the current items 4 and 5). The contributions posted during this second week have reinforced part of these five items, and new insights have been added to the former list.

1.- Restoration Ecology certainly is not a new discipline, as it has been pointed out by various participants (James Aronson Luis Balaguer, Mario González, Jurgen Tack and Beata Woziwoda). However, "it is now in a phase of expansion and internationalisation" (James Aronson). Jurgen Tack goes further and says that "Restoration ecology is a major issue because politicians are using it to send a positive signal to the public".

2.- Different authors insist on the necessity that ecologists build up a conceptual framework of the objectives, methods, and evaluation of Restoration Ecology. On top of this, they (us) have the responsibility of pursuing a more synthetic, holistic approach of ecological restoration as opposed to the current dominant "technological and engineering" approach. Technology is useful, and often pertinent, to solve restoration problems. However, the issue of rebuilding the structure and function of ecosystems that translates into services to humankind must be always present (see item 7).

3.- The major consensus of all contributions was that restoration projects should involve multidisciplinary teams including a variety of basic and applied scientists and engineers (Ruben Álvarez, Luis Balaguer, Emil Ivanov, Mario González and myself). We are far from reaching this target. Actually, there seems to be an stupid "divorce" or dichotomy between scientists and engineers. It is the responsibility of all of us to reach a common language as an starting point.

4.- Two authors, Mike Jordan and F. Xavier Pico, link conservation biology to ecological restoration. Thus, "basic science" is important to meet the goals of applied science. Pico summarised the European Union TRANSPLANT project that "aims to to develop sound guidelines for active species-level restoration measures, including re-introduction and taking into account the genetic, demographic, and landscape-level risks involved". Mike Jordan claims that "the direct re-introduction or restocking of animal and plant species can be conducted as either a single-species based conservation action or as part of a multi-species habitat restoration programme. The Reintroduction Specialist Group of the IUCN Species Survival Commission (SSC) comprises a global network of over 300 experts and practitioners co-ordinated both regionally and taxonomically whose role is to support and guide such activities and disseminate good practice."

5.- Rob Marrs dived into another application of restoration ecology: soil rehabilitation. He considers that "existing soil damage can only be mitigated in three ways: (1) an acceptance of increased desertification in areas with a Mediterranean climate - no action other than a

socio-political one is required, (2) a positive attempt to maintain high quality habitat over as wide an area as possible, or (3) an acceptance that damage will occur and large scale-restoration will need to be implemented and funded".

6.- ¿Passive restoration or active restoration? Edith Allen found in an study in the coastal sage scrub of southern California "that natural successional processes will not return this vegetation to its original composition, so restoration is needed if a return to native shrubland is the goal". Similarly, Beata Woziwoda thinks that "human activity is needed if a return to native communities, with original structure and species composition, is the goal and if the main subject of nature conservation can't exist without active (human) intervention". Further, Emil Ivanov believes "that adaptive management is an appropriate approach, which could be applied in any case, involving ecosystem protection, restoration or sustainable management".

7.- James Aronson focuses on Restoring Natural Capital, "a concept that should greatly facilitate the integration of ecology and economics while also contributing to the sound management, conservation and, conceivably, the improvement of the biologically-rich and economically valuable, cultural, semi-cultural or natural landscapes and ecosystems". "In the multi-faceted, biological and cultural 'hot spot' Mediterranean region, we must begin to carry out evaluations, estimations, predictive modelling and large scale, long-term experiments, using combined ecological and economics tools and metrics, so that a RNC approach can be cultivated for application to emerging ecological economics and public policy forums. The contribution of Axel W. Drescher on "Impacts of agricultural innovation and transformation of the mountainous hinterland in the Mediterranean - an example from southern Spain (Costa Granadina)" also links economics and ecology within a landscape context.

8.- Jurgen Tack considers that "it would be more interesting to bring together political leaders from the Mediterranean region to discuss a political response to those threats. This is only possible when scientists speak with one voice, when your public is informed on causes and consequences. What we really need is SCIENCE COMMUNICATION".

From the above summary I have extracted the following conclusions.

1) Restoration Ecology is not a new but an expanding discipline, partly because politicians are using it to send a positive signal to the public.
2) In spite of technology is useful to solve restoration problems, the issue of rebuilding the structure and function of ecosystems that translates into goods and services to humankind (Restoration of the Natural Capital) must be always present.
3) Restoration projects should involve multidisciplinary teams including a variety of basic and applied scientists and engineers. We are far from reaching this target.
4) "Basic science" is important to meet the goals of applied science. Two direct applications lie on the fields of conservation biology and soil erosion control.
5) Active restoration rather than passive restoration is usually needed.
6) Improvement of science communication is an urgent necessity in the field of restoration ecology.

These conclusions pulled out from your contributions will be presented at the Almería final meeting of this conference. If there is something that have been missed or misunderstood, please do not hesitate in mentioning it.

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