Sustaining livelihoods and Biodiversity-

Attaining the 2010 target in the European Biodiversity Strategy

Report of an electronic conference, May 2004

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NATURAL ENVIRONMENT RESEARCH COUNCIL

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Preface

Research on biodiversity is essential to help the European Union and EU Member States to implement the Convention on Biological Diversity as well as reach the target of halting the loss of biodiversity in Europe by 2010.

The need for co-ordination between researchers, the policy-makers that need research results and the organisations that fund research is reflected in the aims of the BioPlatform network. BioPlatform is a network of scientists and policy makers that work in different fields of biodiversity and aims at improving the effectiveness and relevance of European biodiversity research, fulfilling functions that provide significant components of a European Research Area. BioPlatform supports the existing "European Platform for Biodiversity Research Strategy" (EPBRS), a forum of scientists and policy makers representing the EU countries, whose aims are to promote discussion of EU biodiversity research strategies and priorities, exchange of information on national biodiversity activities and the dissemination of current best practices and information regarding the scientific understanding of biodiversity conservation.

This is a report of the BioPlatform E-conference entitled "Sustaining livelihoods and Biodiversity- Attaining the 2010 target in the European Biodiversity Strategy" preceding the EPBRS meeting to be held under the Irish Presidency of the European Union in Killarney, Ireland from the 20th to the 24th May 2004. This e-conference and meeting aim to identify specific research priorities for the EU Biodiversity Action Plans to reach the 2010 target.

Summary

Background: research, targets, strategies, action plans, livelihoods and monitoring

The global loss of biodiversity has been recognised through the EU commitment to halt biodiversity loss (in the EU) by 2010 and the WSSD target to significantly reduce the rate of global biodiversity loss by 2010. In Europe we are well placed to address these targets through the European Community Biodiversity Strategy (COM (98)42), which was produced in 1998, followed in 2000 by four Biodiversity Action Plans (BAPs):

- Biodiversity Action Plan for Agriculture
- Biodiversity Action Plan for the Conservation of Natural Resources
- Biodiversity Action Plan for Economic and Development Co-operation
- Biodiversity Action Plan for Fisheries

There is, however, no evidence of substantial progress towards halting the loss of biodiversity and in 2003 the European Council noted the need "to accelerate work towards a more responsible management of natural resources, including action to meet the 2010 targets for biodiversity." This has resulted in the preparation by the European Commission of a '2010 Delivery Plan' aimed at delivering the commitments to halt biodiversity loss in the EU by 2010 and contributing towards significantly reduce the rate of global biodiversity loss.

The European Commission is therefore currently leading a review of the Biodiversity Strategy and Action Plans. Working Groups have considered the implementation, effectiveness and appropriateness of each of the BAPs.

Research can play an important role in halting biodiversity loss: Theme 3 of the Biodiversity Strategy considers "Research, identification, monitoring and exchange of information". As part of the review process the European Platform for Biodiversity Research Strategy (EPBRS) was asked to consider this element of the Strategy and will complete a second draft of a report on Theme 3 in May 2004.

This e-conference represents a second step in the review process. Its aims were to consider the research priorities for implementation of three of the Biodiversity Action Plans in light of the call for reinforced action to meet the targets on biodiversity loss. A MARBENA e-conference considered the Biodiversity Action Plan for Fisheries. The e-conference also included two cross-cutting sessions one on Sustaining Livelihoods and one on Monitoring, Indicators and Reporting.

Biodiversity Action Plan on Agriculture

Agricultural activities affect the vast majority of the European landscape and they are seen as the major drivers of biodiversity within each of its biogeographical regions. The aim of the Biodiversity Action Plan for Agriculture (BAP-AGRI) is to promote the conservation and sustainable use of biodiversity in agricultural areas through, in particular, agri-environmental measures, a reduction in agrochemical inputs, organic farming, the promotion of extensive farming systems, conservation of high nature value farming systems, the maintenance and development of linear and isolated features, and the preservation of threatened crop and livestock varieties.

The e-conference session on BAP-AGRI focussed mainly on the impacts of agricultural practices on biodiversity and the effectiveness of agri-environmental schemes. Both were considered in a range of countries, from Ireland to Romania, and from the Mediterranean to alpine areas. The session also considered the urgent need to understand the impacts of changing agricultural policy in the new Member States to the EU. We were also reminded of the presence within the EU of the 7 so-called ultra peripheral regions – the Azores, Canaries, French Guyana, Guadeloupe, Madeira, Martinique and Réunion. This session considered both the development and implementation of monitoring and assessment methodologies and the need for cost-effective, rigorous experimental designs to quantify the impacts of agricultural practices.

This session was closely linked to the overall theme of the e-conference – Sustaining livelihoods and Biodiversity. Contributors considered the concept of a "living countryside", whereby a sustainable livelihoods approach also aims to promote a biodiversity-rich rural landscape. Other socio-economic aspects considered were the relative cost-effectiveness of habitat-based and species-based payment schemes, and the management of conflicts arising from the implementation of agri-environmental schemes.

Research priorities identified during the session included: studies on the impact on biodiversity of agricultural practices, from intensification to abandonment; research on the ecological and economic effectiveness of agri-environmental schemes; and research on understanding, avoiding and dealing with conflict (from ecological, social and economic perspectives) arising from, in particular, the implementation of agri-environmental schemes. Contributors also highlighted the need for research in support of decision-making, from farm to policy scale, and recommended more long-term studies, research from local to landscape scale, and the integration of this research. The contributions also demonstrated the need for integrated research across the EU.

Biodiversity Action Plan on the conservation of natural resources

The aim of the Biodiversity Action Plan for the Conservation of Natural Resources (BAP-NR) is to restore, maintain and improve the favourable conservation status of natural habitats and species of wild fauna and flora. Several specific measures are planned to achieve this, including the implementation of EU directives, including the Water Framework Directive, the Habitats and Birds Directives, and the Natura 2000 network, and the protection of wetland habitats.

The e-conference session on BAP-NR aimed to identify research needs for the achievement of the objectives listed in the BAP as well as methods of monitoring the success of the above-mentioned measures, and the development of new measures. Within the session, contributions from participants focussed on the efficiency of protected areas at present, possible improvement to these areas, increased communication and cooperation between researchers (from both natural and social sciences), managers, and local people. The session also considered the need for a European scale approach to the conservation of natural resources.

Research priorities identified during the session included the inventorying and mapping of biodiversity; research into the genetic variation and specificity of selected species; research into the effects of climate change and other anthropogenic factors on biodiversity (especially on threatened species); research into the impacts of invasive species; research on the role and potential of ecological corridors; the development of modelling tools

to integrate ecological aspects and conservation objectives; research on the effects of nature conservation areas (including the measurement of habitat quality); research on restoration and management techniques; research into the potential for tradable permits in the field of biodiversity; and research on the interactions between protected and non-protected areas.

Biodiversity Action Plan on Economic and Development Co-operation

The Biodiversity Action Plan for Economic and Development Co-operation (BAP-EDC) consists of 18 main actions, aiming to address priorities set out in the EC Biodiversity Strategy. The purpose of these actions is to integrate biodiversity into policies, programmes and projects being developed through EC economic and development co-operation and help to build the EC capacity to address biodiversity issues as part of economic and development co-operation.

A number of participants contributed to the BAP-EDC session, addressing structural, procedural and capacity related issues. Topics discussed during the session included the identification of research needed to successfully integrate biodiversity into economic and development co-operation, links between development, biodiversity and poverty alleviation, equitable sharing of biodiversity costs and benefits and the role of participatory approaches to BAP-EDC.

The research priorities identified included methods to increase participatory and integrative approaches (including methods to increase collaboration between all stakeholders, information sharing, and research into the costs and benefits of participation in the long term); research into the pressures upon and the status and trends of biodiversity resource uses; links between biodiversity and livelihoods; research on ways in which to internalise biodiversity values (access to future production values, legal status given to traditional uses, benefit sharing, internalising international concerns, promotion of positive private investment); research into institutional economics and the co-management of natural resources; development of mechanisms to assess a) the effects of EU policies not directly related to biodiversity on biodiversity, and b) the effects of biodiversity policies on socio-economic factors in developing countries.

Sustaining livelihoods

The Sustaining livelihoods and BAP-EDC sessions overlapped to a certain extent. Participants in this session focussed mostly on identifying links between livelihoods, lifestyles and biodiversity and the possible conflicts between development and conservation aims.

Research needs identified included research (ecological and socio-economic) on the core ecological processes supporting ecosystem services and livelihoods as well as the factors influencing these processes; research in economic systems in order to answer current needs and those of future generations; methods to take biodiversity values into account in decision making processes; research into the effects of biodiversity conservation policy instruments on livelihoods and biodiversity; research on existing and potential impacts of climate change on the terrestrial and marine biodiversity, economic sectors, poverty and the sustainable livelihoods of communities.

Monitoring, Indicators and Reporting

Biodiversity monitoring, indicators and reporting is a critical aspect of the Biodiversity Strategy and BAPs. For example, the Strategy states that the monitoring and indicators "is an essential element of this strategy because it will provide the required information to assess the performance and impact of the Action Plans and other measures". Since the Strategy was written, the need for monitoring in relation to policy goals has become even more important with both an apparent, but poorly quantified, decline in global biodiversity and also the agreement by EU Member States to halt biodiversity loss in Europe by 2010.

This session was held against a background of recent progress on the implementation of biodiversity indicators. A European Commission Working Group on Monitoring,

Indicators & Reporting proposed a set of 15 headline indicators (Level 2 indicators) in April 2004. They also acknowledged the need for a single structural indicator (Level 1) and for indicators linked to policy sectors (Level 3). Progress has also recently been made at the CBD and pan-European levels.

This session of the e-conference was in three parts: it considered the research needed to ensure that we can adequately monitor 1) changes in the state of biodiversity, 2) the impact of single and multiple drivers of biodiversity and 3) the impact of policy responses to biodiversity loss, particularly the measures included in the BAPs, the overall impact of the Biodiversity Strategy and the 2010 target to halt biodiversity loss.

The following priorities were proposed. Researchers should be involved in the short-term implementation of indicators to monitor status and trends of the components of biodiversity proposed for use in the EU both to help to access the necessary methodologies and to identify any remaining research needs. Research efforts should focus on the medium term implementation of indicators on sustainable use, threats to biodiversity, ecosystem integrity and ecosystem goods and services, funding to biodiversity, and public awareness and participation. At the same time as the proposed state indicators are implemented, a series of intensively monitored sites should be established: a) to validate the state indicators and monitoring methods used to derive data for these indicators; b) to provide a more comprehensive assessment of biodiversity; c) to understand the relationship between biodiversity, ecosystem function and the services provided by terrestrial and aquatic ecosystems; d) to quantify the contribution of natural and anthropogenic (including policy influences) drivers on biodiversity; and e) to develop improved monitoring and indicators programmes.

List of contributions

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The biodiversity action plan on agriculture and indicators	Kevin Parris
Using AES to create a market for biodiversity	Frank Wätzold
RE: Using AES to create a market for biodiversity	David Cope
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RE: Research needs on the methods of conflict resolution in the implementation of agri-environment schemes	Klaus Henle
RE: Research needs on the methods of conflict resolution in the implementation of agri-environment schemes	David Gowing
Research needs on the design, analysis and statistical power of studies of the effects of agricultural practices on biodiversity	J. Perry, S. Clark & P. Rothery
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Research needs for the Biodiversity Action Plan on the conservation of natural resources	B. Jedrzejewska & B. Jaroszewicz

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Selecting threatened plants	Sandra Knapp
RE: Selecting threatened plants	Miguel Segur
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Biodiversity Action Plan- Agriculture

Research needs for the Biodiversity Action Plan on Agriculture: opening comments

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Agricultural activities affect the vast majority of the European landscape and they are seen as the major drivers of biodiversity within each of the biogeographical regions. Policy initiatives and the level of the EU and within Member States are being designed to arrest the loss of biodiversity associated with these activities. However, do we have an adequate understanding of the major agricultural drivers of biodiversity loss? Are the drivers the same throughout Europe? Do we know whether of the agri-environmental measures currently being introduced and operated have positive effects on biodiversity? Do we need more research to help resolve social and economic conflicts which may arise because of the introduction of such schemes?

The majority of the land surface of Western Europe is given over to agricultural activities and, as such, agriculture is one of the primary drivers of the biodiversity within the EU. It plays a significant role in the shaping of the landscape, and many natural landscapes have been shaped by agricultural use over time. There has been over-application of fertilisers and pesticides, soil compaction associated with intensive tillage and altered water balances, removal of linear features such as hedgerows, from the landscape and, in some regions, land abandonment are all perceived as having deleterious effects on biodiversity. However, European agriculture is very diverse in the nature and structure of the production units, the crops grown and the intensity of management. This means that the extent and causes of environmental impacts are likely to vary significantly across bio-geographic regions.

During the e-conference we will address whether we know enough about the agricultural drivers of biodiversity, the impacts of agri-environmental schemes and the policy implications of introducing those schemes.

Vast amounts of research have been carried out on the effects of agricultural practices on various components of biodiversity. These extend from studies of the effects of fertilizer and pesticides applications, through management regimes to altered landscape structure and land abandonment. However, do we therefore know enough about the various impacts, or the extent of the variation across the EU, to help inform policy makers in the context of BAP?

Modifying the effects of agricultural intensification or land abandonment will largely be driven by policy and agri-environmental measures. Given that approximately one in seven farmers are currently involved in such measures we should be certain that they have the desired effects before the EU Member States develop guidelines or codes highlighting biodiversity protection and improvement in a given region. Do we know enough about the effectiveness of these schemes? Several studies have suggested that they have little impact. Is this generally the case?

Do we need research on social and economic aspects of agri-environment schemes? Do we need research into methods of resolving conflicts that arise due to the implementation of agri-environmental schemes? Are experimental designs that have been used to examine the effects of such schemes robust and appropriate? Do we know how to adequately disseminate knowledge of the value of the biodiversity that we seek to protect or enhance?

Research Needs on Agricultural Drivers of Biodiversity in Ireland

Gordon Purvis, Faculty of Agriculture, University College Dublin, Ireland

SUMMARY: The following is a personal view of the strategic research needs required to promote and achieve within an Irish context, the aims of the published Biodiversity Action Plan (BAP) for agriculture. This view places paramount emphasis on the need for of a strongly 'applied' research agenda that clearly addresses and supports the needs of policy-makers through the provision of an appropriate scientific knowledge base.

1. The requirement for objective information and intelligence gathering:

There is currently a very substantial deficit in knowledge concerning the actual impact of Irish agriculture on biodiversity and little objective information on the current status and trends of change in biological diversity within agricultural landscapes. Consequently, effective implementation of the BAP for agriculture is, in the first instance, highly dependent on the development and implementation of appropriate, feasible and meaningful monitoring and assessment methodologies to quantify the actual (as opposed to conjectured) trends of change that are taking place. Such an approach is essential for the proper identification of further priority research and policy needs. The development and implementation of appropriate monitoring methods will however, require a sea change in the attitudes of funding agencies, involving recognition that ongoing, long-term funding programmes are an essential requirement for progress. To be scientifically valid, and cost effective, such monitoring needs to be clearly targeted at specific issues, and to be jointly designed and implemented by scientists and policymakers to provide effective intelligence gathering.

In common with changing patterns of agricultural land use across many areas of Europe, an increasing polarisation of Irish agriculture means that its environmental impact, and influence on biological diversity, varies strongly in different agronomic sectors:

Areas of increasing production intensity

A projected 10,000 full-time commercial farmers in Ireland, mainly involved in intensive dairy production, will become more concentrated in the most inherently productive areas of the south and east where increasing competition with other forms of land use for industrial development and urbanisation will combine to put severe stresses on environmental quality and biological diversity. In these regions, there are likely to be three main areas of priority research need, which are not necessarily in conflict with the continued practice of competitive farming:

2. Identification and conservation of existing important habitats and biodiversity hotspots:

The protection of conservation priority areas within geographical regions of intense competition for land use, and the development of effective habitat protection and population management plans at the landscape level will become a priority.

3. Development of within farm conservation methods:

To support conservation plans at the landscape level, it will be necessary to develop policy to maximise the conservation value and benefits of on farm habitats, including field boundaries and other non-cropped areas within the mosaic of cropped field units. To ensure that agriculturally competitive farmers retain a positive and active interest in environmental conservation (in addition to being required to adhere to environmental legislation), it will be necessary to encourage their participation in agri-environmental measures (e.g. the REPS) by providing the necessary incentives to adopt appropriate conservation management strategies for non-cropped land and habitats within their control, which do not constrain their ability to farm competitively.

4. Utilisation of the advantages of biodiversity:

Basic ecological knowledge has always been core to the development of sustainable agricultural systems, and fundamentally underpins all agriculture. However, in more intensively competitive forms of agriculture, the potential of natural biological processes has tended to be overlooked and even surplanted by the development and use of artificial system inputs (fertilisers, pesticides, pharmaceutical drugs etc.). Such natural processes, and our understanding of the functional role of biological diversity in providing them, are key to the concept of 'ecologically sound' agriculture. There is therefore, a continued and ongoing need for applied agro-ecological research, of a traditional agronomic nature, to promote our understanding of biological systems within agriculture. Of particular and ongoing research interest, are the functions and roles of biological populations in the recycling of nutrients and animal wastes, the maintenance of soil structure and fertility, the natural regulation of pest and disease populations, and the development of alternative production systems that promote and benefit from these natural processes.

Areas of extensive production

An expected 25,000-35,000 part-time farmers will continue to farm extensively as mainly beef and sheep producers concentrated in the midland regions of Ireland. These farmers are the most likely to participate in agri-environmental incentive schemes, such as the Rural Environment Protection Scheme (REPS), which, following the Luxembourg agreement of June 2003 to reform the CAP by targeting support payments towards the achievement of environmental and food quality goals, are likely to become the paramount policy tool with which to put into effect many of the major aims of the BAP for agriculture. In addition to the areas of research mentioned above, a range of additional knowledge to promote the conservation of biodiversity within areas of extensive agriculture can be foreseen, which will help to maximise the conservation of biodiversity. These include:

5. Use of traditional farm breeds and crops (enhancing genetic diversity):

The longer-term sustainability of these farmers is likely to depend on their production of produce of perceived quality, rather than quantity or low cost – hence the opportunity to develop new markets for traditional breeds of superior quality, produced in more extensive production systems to which they are better suited. In effect, such a development will call for a re-appraisal and redirection of agronomic research toward environmental and food quality goals, rather than its traditional production orientation.

6. Enhancement of 'within field' diversity:

In addition to the development of 'within farm' habitat conservation strategies (3 above), in extensive areas of production there is a real potential to modify cultural practices within the actual farming system itself so as to benefit and enhance biodiversity within the wider environment. For example, in grassland farming much attention has been paid to the lessening of environmental impact by reduction of nutrient inputs and stocking rates. However to-date, the evidence is that this in itself may do little to enhance biological diversity when the method of sward use itself remains one of intensive rotational cutting and grazing management which severely constrains both structural and botanical species diversity. In contrast, there may be much greater potential to enhance biodiversity within more extensive farming regions by promoting more traditional patterns of grassland use. Such methods have proven to be a very successful strategy for the conservation of particularly charismatic target species, such as the corncrake. However, further basic ecological and agronomic research is necessary to clearly quantify the wider biodiversity benefits of different grazing practices, and to devise the most effective methods of grazing management for the conservation of biodiversity within farmland. Since agricultural grasslands comprise such a large proportion of the Irish landscape, such issues are not inconsequential.

Environmentally fragile landscapes and areas of agricultural abandonment

As in many other areas of Europe, there is abundant evidence of environmental degradation and loss of biodiversity caused by farmers' reactions to mounting economic pressures in marginal production areas, involving e.g. the impact of overgrazing or land drainage in ecologically fragile landscapes, or the actual abandonment of the traditional farming systems that maintain the particular character of landscapes. The Burren region in Co. Clare, is perhaps the best known such region in Ireland, where the abandonment of a

traditional system of cattle winterage on upland limestone pavement is causing the loss of unique botanical diversity to scrub encroachment. However, many other traditional anthropogenic upland and wetland landscapes, particularly in the West of Ireland, are subject to similar environmental degradation due changing socio-economic forces. It seems obvious that ecological knowledge is needed to reverse this type of biodiversity loss. However, on its own such knowledge is unlikely to provide a long-term solution to what is essentially a regional, socio-economic, problem. There is therefore a priority need for research to:

7. Define the needs for optimum management strategies for ecologically fragile habitats:

This primarily relates to the identification of optimum forms of vegetation management to maintain the traditional aesthetic appearance and biodiversity value of the landscape, but also it relates to quantification of knock-on effects on the wider ecosystem and its conservation value.

8. Develop methods for the economic evaluation of the 'multifunctional' role of agriculture in marginal areas:

Research with respect to quantification of the broader contribution of biodiversity and landscape conservation by farmers, to tourism and other recreational activities that are key to regional economic viability, will require the collaboration of ecologists, to quantify the optimum type(s) of land management needed (as in 6 above), and socio-economists to analyse and understand the social context, motives and behaviours of land owners. This multidisciplinary approach will be necessary to create the knowledge-base needed to facilitate the formulation of effective policy instruments that successfully target and promote environmental, social and economic sustainability in agriculturally marginal regions.

Achievement of the BAP aims for agriculture will, as for all other sectors, require a specific concerted effort, and the investment of time and resources in education to promote a wider appreciation of the issues and acceptance of policy aims amongst stakeholders and the general public.

Promotion of Environmentally-friendly Agriculture

Christian Kleps , Romanian Academy of Agricultural and Forestry Sciences, Romania

SUMMARY: The application of some new agricultural practices, based on the most advanced agri-environmental scientific knowledge, especially of those ecologically viable, is a major need in promoting a sustainable agriculture.

The Biodiversity Action Plan for Agriculture recognizes the biodiversity benefits on agriculture, which allows the creation of new varieties and breeds for the achievement of economic, health, technical and ecological objectives. Agriculture benefits for biodiversity are also recognised, by maintaining both wild and domesticated plant and animal species, varieties or breeds, as well as ecosystems, at times under threat of extinction, in the case of non-intensive agriculture.

Looking at the general causes of biodiversity deterioration in agro-ecosystems, the part played by the inappropriate agricultural farming in the general context of production intensification and under-utilization of land is also acknowledged. This is also the case in Romania, where more than half of all nutrient loads in the Danube River originate from agriculture, about one-fourth from private households and about 10 – 13 % from industry. High levels of agricultural pollution, results from: (i) poor agricultural practices, including inappropriate management, storage and application of mineral fertilizers, pesticides, manure and domestic waste; (ii) lack of septic tanks in most of rural settlements; (iii) soil erosion resulting from unsustainable land use; (iv) destruction of the former floodplain areas; and (iv) lack of waste water treatment plants for both small human settlements and intensive animal production.

There are two categories of agricultural pollution: (A) pollution from point sources, especially zootechnical units (i.e. large animal farms, with large emissions and high concentrations of gases, waste water and solid waste; and (B) diffuse pollution due to emissions of chemical substances applied in agriculture: fertilizers, agro-chemicals, but also animal waste once it has been spread on agricultural land. Water quality is measured at point sources of pollution. However, the existing monitoring cannot determine the quantity of pollutants coming from diffuse agricultural pollution into surface waters and groundwater, and it has to be evaluated on the basis of models.

The promotion of environmentally- friendly agricultural practices, which is now well established by Romanian researchers and policy-makers, will maintain or increase agricultural productivity, while reducing non-point source pollution from agriculture. The proposed activities will include: (a) support to farmers' associations to promote more environmentally-friendly agricultural practices, such as crop rotation, integrated nutrient and pest management, conservation tillage systems, riparian buffer strips and improved livestock management; (b) establishment and management of manure and refuse storage areas and their field applications; (c) soil testing; and (d) monitoring and evaluation of soil and water quality. These activities will result in reducing the nutrient run-off into surface and ground-water as well as: (i) protecting the long-term fertility of soils by maintaining organic matter levels, fostering soil biological activity; (ii) reducing cost of production through the use of organic materials including crop residues and livestock wastes; (iii) better management of livestock manure, including the elimination of direct discharges to surface water, proper storage and application; (iv) improved management of domestic waste.

Further research will also have to extend to ecological agriculture, in order to improve the biodiversity in agri-ecosystems and for long-term environmental benefits.

Research needs on agricultural drivers of biodiversity in Alpine habitats

Christoph Scheidegger and Ariel Bergamini, WSL, Switzerland

SUMMARY: The authors recommend research on time lags of recolonisation, dwarf-shrub, bryophyte- and lichen dominated or nival habitats and increased links between spatio-temporal aspects of landscape ecology, landscape aesthetics and stability against natural hazards in future alpine research programmes.

Alpine habitats, i.e. habitats in mountainous areas both above and close to the natural tree line, belong to the most species-rich ecosystems and large parts of them are agriculturally used. Agricultural management of Alpine habitats goes back to, at least, early Medieval times and, thus, is an important determinant of alpine biodiversity.

Traditionally, agricultural management at lower altitude in alpine regions included a broad variety of cereals including local varieties of *Secale*, *Hordeum* and *Fagopyrum*. However, in most areas the traditional, small fields with arable crops have been replaced by grassland or have been completely abandoned, and major parts of the local agro-diversity has already been lost (Pro Specie Rara (1995): Landwirtschaftliche Genressourcen der Alpen). Grassland management, often linked to transhumance was concentrated at higher altitudes. Recent agriculture in alpine regions has been limited to grassland management both at lower and higher altitudes. In lowland areas of Central Europe, a rapid succession "camouflages" former land-use types within a few decades. Because of a much shorter vegetation period and harsh environmental conditions in the Alpine regions, effects of past land-use are extremely long lasting here and so will be the traces of present land-use change. Recent simulation experiments revealed very slow recovery of forests after cessation of cattle grazing, and more than 500 years are probably needed to obtain a forest with a diverse tree species composition. Various research needs arise because of this low and often very local, dynamics in alpine habitats.

Time lags of recolonisation are poorly understood, but we have evidence that they may involve several hundred years and may therefore determine the succession after land-use change. This has strong implications on restoration- and conservation biology. E.g. destruction of the vegetation (ski slopes) may remain visible over many decades, and the transformation of a plantation forest into one that has a higher structural and species diversity requires centuries.

Furthermore, long-term experiments have revealed that succession dynamics largely depend on patch size and distance from diaspore sources, e.g. forests. Various landscape parameters, such as size, shape and connectivity of habitat patches are increasingly important at the altitudinal limits of species and / or communities.

Although research on ecosystem functioning of alpine meadows has a long tradition, the knowledge on dwarf-shrub, bryophyte- and lichen dominated or nival habitats is still poor. These habitats do not only present a significant component of biodiversity, but also play an important role in slope stability, surface water storage and mineral cycling under extreme ecological conditions.

Agricultural and forestry management have formed a small-scale landscape pattern, of outstanding touristic value since the mid 19th Century. Modern land-use change may drastically alter landscape aesthetics and, therefore destroy touristic values for centuries to come. Furthermore, it is suggested that succession can negatively influences slope stability, possibly increasing the risk of natural hazards in a changing landscape. Links between spatio-temporal aspects of landscape ecology, landscape aesthetics and stability against natural hazards have to be strengthened in future alpine research programmes.

Research needs on agricultural drivers of biodiversity in the Mediterranean region

Frederico Fernandez-Gonzalez, Faculty of Environmental Sciences, University of Castilla-La Mancha, Spain

SUMMARY: EU Mediterranean countries harbour a considerable amount of the European biodiversity due to historical reasons as well as particular disturbance regimes. Farming in the Mediterranean follows a long tradition and is characterised by low productivity. Threats in the Mediterranean include land intensification and abandonment. Research needs include the direct evaluations of the effects of Action Plans on biodiversity. Interdisciplinary research is needed for a correct evaluation of the effects and local scale implementation of agricultural regulations. Another research priority is that of the effects of climate change on agro-ecosystems in the Mediterranean.

EU Mediterranean countries harbour a considerable amount of European biodiversity. The high levels of Mediterranean biodiversity are related to several historical factors, like the refuge role played by these southern areas during past climatic changes and the variety of habitats promoted by their lithologic and topographical complexity. Particular disturbance regimes, like wildfires, natural herbivory and a high inter-annual climatic variability have contributed to the maintenance or enhancement of this biodiversity. Mediterranean areas are among the first exposed to human management in Neolithic times, and an important part of their biodiversity is also linked to the old agricultural land-uses practiced across centuries. Typical Mediterranean landscapes of high conservation value like cereal steppes, dehesas (open, grazed forests) or terraced slopes have an agricultural origin and extend over thousands of km^2.

The high species richness of Mediterranean landscapes is in a large part due to species found at early or intermediate successional stages, hence favoured by moderate disturbances and open habitats. Species turnover within or between landscapes is a major component of overall Mediterranean species richness, enhanced by habitat heterogeneity but also by the coexistence of varied land-use types or intensities or even different land-use histories in mosaic-like patterns. The state of the art in the knowledge of Mediterranean biodiversity (inventory and patterns) is still below the EU average for most of the taxonomic groups.

A large part of Mediterranean agriculture is characterized by low productivity, due to the combined effects of summer drought, weather variability, limited soil fertility and adverse topography. Mediterranean regions are now facing up to the two main current trends in agricultural land-use: intensification or marginalisation.

Land abandonment in the Mediterranean involves an additional threat to biodiversity derived from the increase in fire hazard associated with shrub encroachment. The current fire regime is far from natural due to the prevalence of human sources of ignition. Progress in fire fighting combined with land abandonment and fuel accumulation are paradoxically increasing the incidence of large wildfires under extreme weather conditions allowing fire propagation. There are strong evidences supporting that these large wildfires can induce the homogenisation of post-fire landscapes with adverse effects on biodiversity. An implication of this issue deals with the adaptation of CAP afforestation to this particular disturbance regime in the Mediterranean.

Mediterranean areas are also very sensitive to land-use intensification, with particular stress on water overexploitation, pollution, eutrophication, salinization, soil erosion, overgrazing due both to livestock and cynegetics, and landscape homogenisation, including the negative impacts of growing mechanization on microtopography. The long history of human extensive management and the existence of large species pools allow us to hypothesize that Mediterranean cultural systems may react well to measures alleviating the impact of agricultural intensification on biodiversity. Nevertheless, the low economic productivity of many Mediterranean agro-ecosystems makes them very sensitive to socio-

economic drivers. Competing policies aimed at subsidizing or compensating for alternative agricultural practices may bias landowners easily towards these short-term but economically more interesting options. This can diminish the diversity of agricultural land-uses and generate unexpected negative impacts on biodiversity.

Recent research highlights the need for direct evaluations of the effects of Action Plans on biodiversity, because the supposed benefits cannot guaranteed as they depend upon the measures implemented and the initial conditions of the biological systems to which they are applied. In the case of Mediterranean countries, such evaluations need to be done at least at the landscape scale, which is crucial for most of the patterns of Mediterranean biodiversity.

Direct monitoring of biodiversity should be based on more taxonomic components than those better known, because the evidence supporting the reliability of surrogates is weak. Despite the large surfaces of land currently under CAP regulations in favour of biodiversity, direct and holistic monitoring of their effects is still scarce and far from systematic. Moreover, regulation measures are commonly adopted by packages making the correct evaluation of their individual and synergistic effects difficult. Adaptive management approaches, explicitly involving experimentation in the management processes, should be adopted at least in selected sites representative of the corresponding policies and biogeographical units.

Interdisciplinary research involving socio-economic and natural scientists is needed for a correct evaluation of the effects of agricultural regulations and even for their implementation at local scales. Essays carried out on Mediterranean cultural systems show that when biodiversity values are translated to economic terms the balance changes drastically in favour of sustainable land uses. Some related issues, like the interactions between crops and livestock, the problems dealing with tree regeneration in the dehesas, or the feedbacks between land abandonment and wildfire, would benefit from this kind of integrated approaches.

Although climatic change is not expected to interfere with the EU 2010 target for stopping biodiversity loss, it will do so in the next decades. Recent climate change models of higher resolution point show changes at least in the western Mediterranean countries. As the impacts of such severe changes could override some measures of the BAP for Agriculture, further research will be needed at short term about this subject.

In summary, this contribution proposes that Mediterranean countries still need research on the impacts of agricultural drivers on biodiversity and the processes allowing its maintenance. Research should be holistic, integrative of socio-economic approaches, based on adaptive management and able to solve questions at the landscape scale.

Research needs for the Biodiversity Action Plan on Agriculture: Summary of session 1 and introduction to session 2

Tom Bolger, Session chair, Department of Zoology, University College Dublin, Ireland

The decline in farmland birds across Europe is well documented; however, with few exceptions, the causes of the declines are not completely understood. This is largely because factors such as weather, climate change, disease and predation may be important in addition to changes in agriculture. This is presumably the case for many components of diversity. The definitive separation of such effects will require long-term experiments. This, i.e. the need for long-term studies, is one of three themes that emerged strongly from the contributions made to this session last week and was mentioned by Gordon Purvis, Christoph Scheidegger and Federico Fernandez. The second issue, which was mentioned in several of the contributions, was the need for research not only on the effects of agricultural intensification but also of land abandonment. The third was the need for taking a landscape view of effects.

During this week we will discuss whether additional research is needed in terms of the design and assessment of the effects of agri-environment schemes on biodiversity.

Environmental and rural economy measures will play a larger role in the Common Agricultural Policy (CAP) in the future. This will be achieved by replacing the emphasis on support for production. These changes are aimed at addressing some of the detrimental aspects of previous policies and making the CAP more environmentally sound.

Several agri-environment schemes are already in operation across Europe and indeed some, which were originally designed for other purposes, have emerged as apparently important in terms of conserving biodiversity. One obvious example is the practice of setting land aside from agricultural production.

In the early 1980s, productivity within the EU had increased to such an extent that surpluses of many agricultural products were being produced. Compulsory set-aside of land from the production of arable crops was introduced as part of the 1992- McSharry reforms of the CAP. This is now seen as having beneficial effects on biodiversity. For example, both bird abundance and diversity are often greater on set-aside than arable fields. However, the effects were also seen to be dependent on the form of set-aside management employed. Are there further deficiencies in our knowledge of the effects of a well-established practices such as set-aside, what do we know of the other agri-environmental programmes which are being implemented or suggested? Where is research needed?

Land abandonment or reduced management may not always be beneficial. Last week, Federico Fernandez pointed out the danger to biodiversity of land abandonment in Mediterranean regions. How much do we know about the effects of intensity of management? Would reduced intensity of grassland management as mentioned by Gordon Purvis have similar effects across Europe? How will the effects of all of these vary across the different regions of Europe? Do we know?

The decrease in farmland habitat heterogeneity is believed to be major factor in the decreasing farmland biodiversity across many areas in the EU. Therefore we apparently need to address issues of landscape structure. Are these issues adequately addressed in current agri-environment schemes and do we know enough about the success rates of any such proposals? These are all areas where policy makers really need advice from scientists. Do we have the information to provide such advice?

Research needs on the social aspects of agri-environmental schemes as they relate to the protection of biodiversity

Joseph Mannion and Jim Kinsella, Faculty of Agriculture, University College Dublin, Ireland.

SUMMARY: The authors explain the notions of the "living countryside", the sustainable livelihoods approach and on the Rural Environmental Scheme in Ireland. Suggested research focuses on possible means to ensure a balanced stock of assets at household, farm and community levels through the combination of policy and non policy drivers; indicators of impact of environmental schemes on assets; key influencers of uptake of schemes by Irish farm households and the capacity gaps within the institutions that deliver these schemes.

The 2nd European Conference on Rural Development (Salzburg, 12-14 November 2003) organised by the European Commission, adopted a series of conclusions and principles aimed at guiding future policy planning for rural areas. Enshrined in the conclusions was the concept of a 'living countryside', a key principle that was stated as: "preserving the diversity of Europe's countryside and encouraging the services provided by multifunctional agriculture …". It concluded that: "A living countryside is essential for farming, as agricultural activity is essential for a living countryside". Achieving a balance in the relationship between farm households, farming and protection of biodiversity is thus a key goal of future EU rural policy. Agri-environmental schemes are the publicly supported policy instruments to encourage and enable this to happen in the context of the price-cost squeeze in agriculture compounded by the pressures on farm businesses to grow.

A sustainable livelihoods approach can be applied to help better understand the dynamics at play within a 'living countryside'. The approach, based largely on the work of Carney (1998), Farrington et al. (1999) and more recently DFID, has emerged from the need to identify the critical elements and processes which influence the sustainability of development interventions. At the heart of the sustainable livelihoods concept is the asset pentagon reflecting the stock of capital available to households that interfaces with institutions to result in livelihood outcomes (Figure 1). Within the asset pentagon is the stock of natural capital available to the households at any time and which are enhanced or depleted by their relationship with policies and the market place. In Ireland the Rural Environmental Scheme (REPS), adopted by one third of Irish farmers, has had a strong influence on protecting and enhancing the stock of natural capital in the Irish countryside, including biodiversity (Mannion et al., 2001).

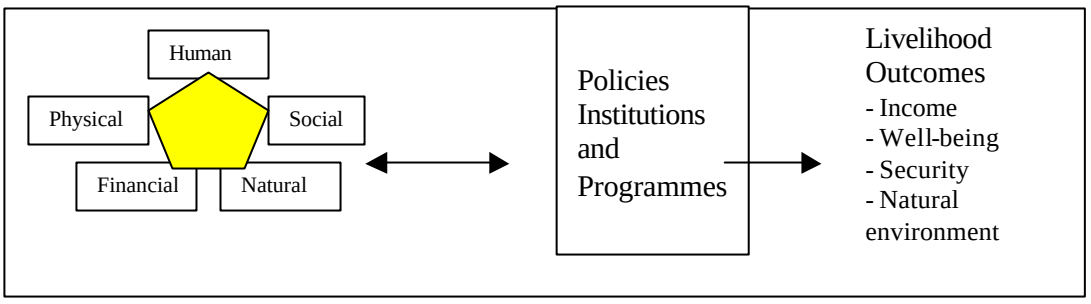

Figure 1. Sustainable Rural Livelihoods Framework (Adapted)

While the REPS is set to remain an important agri-environmental scheme in Ireland and the EU for the short-medium term future, sustainability of the natural capital embedded in the countryside rests on how farm households respond to policy and non-policy drivers (such as market and societal factors) over the long term.

Therefore the questions which research must attempt to address are:

- How to ensure a balanced stock of assets at household, farm and community levels through the combination of policy and non policy drivers?
- More specifically the questions related to society, schemes and biodiversity are:
- What is the optimum balance within the asset pentagon?
- What are the relevant indicators of impact of environmental schemes on assets?
- What are the key influencers of uptake of schemes by Irish farm households?
- What are the capacity gaps within the institutions that deliver these schemes?

Research needs on the effectiveness of Agri-environment schemes in the protection of biodiversity in the UK and Ireland

Dan Chamberlain, British Trust for Ornithology, Scotland, UK.

SUMMARY: Research into arable agri-environment schemes is well developed for some taxa, but there remains a need for further research into a broader range of taxa, continued monitoring to assess long-term impacts, a greater emphasis on research into pastoral system and an assessment of the scale at which schemes should be applied (e.g. in regional or national area covered) to have wider biodiversity impacts.

Declines in farmland biodiversity have been severe in many countries of the EU. Agri-environment schemes, whereby land is managed at a lower intensity, sometimes with prescriptions to target particular groups of animals or plants, have been widely introduced (e.g. 20% agricultural land area in the EU in 2000). Agri-environment schemes are highlighted as a way to reverse declines in farmland biodiversity in the EU Biodiversity Action Plan for Agriculture. However, recent criticism of these schemes (Kleijn & Sutherland, 2003) has highlighted that they are often poorly implemented and monitored, and don't deliver their specified goals. The lack of rigorous monitoring and evaluation of schemes means that it is very difficult to say how effective they are in protecting and promoting biodiversity on farmland. Continued monitoring of the impacts of these schemes should be made for a number of components of biodiversity as benefits may take several years to accrue. Where possible, comparisons should be made with conventional agriculture using baseline data and/or ecologically matched sites.

In Britain at least, research has focussed on arable schemes. We have a good understanding of the factors that affect diversity/abundance of a number of taxa in arable systems and are thus able to make specific recommendations. In the case of birds this has been done through a process of assessing the value of pilot schemes before making them available at a national scale (Bradbury & Allen, 2003, Evans *et al.*, 2002). The same needs to be done for future proposed options and other taxonomic groups. There is less focus on pastoral systems, yet there is mounting evidence that intensification in these areas (grassland 'improvement', increased stocking densities) and loss of mixed farming has had severe effects on biodiversity. For example, many farmland birds have shown local extinctions in northern and western Britain and there have been similar losses over most of Ireland. Although there is ongoing research into factors that promote diversity in pastoral agriculture, our understanding remains relatively poor compared to arable systems. Particularly important research areas are: reductions in stocking densities (a likely scenario under the change in headage payments), value of mixed farming (e.g. introducing small arable components to livestock farms) and restoration of traditional grassland habitats (hay meadows, wet meadows).

For several species, it is possible to list beneficial management options, but not to answer the key question 'how much is required to impact on populations?'. Issues of scale therefore need to be considered when introducing these schemes where the goal is to reverse population declines.

There are biases in the research programmes in the taxa covered. Birds, butterflies, beetles, arable weeds, earthworms and soil-dwelling larvae are relatively well understood. However, other taxa may also be important components of diversity yet they are subject to relatively little research (e.g. bats, small mammals, collembola). It may not be feasible to monitor such a range of organisms. In these cases indicators may be used. However, any indicators proposed should be based on detailed research so we know that they are reliably representative of as wide a range of taxa as possible. A research approach that considers this question, focussing on arable and pastoral systems separately, would be welcomed. Thanks to Juliet Vickery for discussion.

Research needs on the effectiveness of Agri-environment schemes in the protection of biodiversity in Alpine regions

Peter Duelli and Felix Herzog, WSL Birmensdorf and Agroscope FAL Zurich, Switzerland

SUMMARY: AES in Alpine regions are vital for preventing farmers from abandoning remote areas, and thus for maintaining a particularly rich and sometimes spectacular biodiversity. Landscape diversity demands for a variety of AES, which may not fit the schemes developed for the lowlands. Accordingly, hardly any scientific research has compared different options and tested their effects on biodiversity.

In Alpine regions, agricultural production has always been more laborious and less productive than in the lowlands. Without subsidies, farmers in these areas have the choice to intensify their management drastically or to abandon their farmland. With an open market and cheap international transports, farmers in mountainous areas have more and more problems to keep on going in a competitive way. On the other hand, biodiversity is notably rich, colourful and often spectacular in Alpine regions, so the public and especially the tourist industry have a keen interest in keeping the farmers in the remote Alpine areas. Extensive agriculture is the only way to maintain the present level of biodiversity in Alpine landscapes, because intensified agriculture damages biodiversity and abandoned areas turn into forests, where most of the species adapted to open habitats disappear. Consequently, AES for promoting biodiversity are absolutely vital for the farmers, and for biodiversity, in Alpine landscapes. In fact, Alpine farmers are probably the most important and most distinct landscape gardeners for biodiversity conservation among all farmers in Europe.

It is a scientific challenge to find affordable AES for Alpine regions and to focus the money on the most effective measures: Mowing or pasture? Keeping subsidised sheep with subsidised wolf protection – or no sheep? Enhance indigenous, wild, semi-wild or (re-) introduced large herbivores for grazing? Hunting: yes or no? Subsidise pasture woodland, after cattle had been banned from forests for more than 100 years? How much public money should be paid for preventing natural disturbance dynamics such as avalanches, fire, flooding, landslides, and for restoration afterwards? In remote Alpine regions these subsidised activities are more expensive than in the lowlands, and even more so after the farmers have left. It is crucial for government officials, but also for the acceptance by politicians and taxpayers in general, to know what AES pay for, and to know that they are successful. As long as the proposed EU-indicators for monitoring AES simply measure the areas under AES, the acceptance of farmers, or the amount of money spent for AES, we will still be ignorant of their effect on biodiversity. A drastic example is known from the Netherlands (admittedly not an Alpine region), where the AES have shown very little effect on biodiversity (Kleijn et al. 2001), but the official EU-indicators of the Biodiversity Action Plan would attest a great success. The evaluation of AES should be part of the scheme itself right from the start. Scientific rigour must be guaranteed, namely with respect to the sampling design and the reproducibility of the results. The evaluation has to be independent from political authorities in order to be credible. Long-term monitoring has to be combined with punctual evaluation studies, which assess the causal relationships between policy measures and observed effects. It is indispensable that the assessment of AES be based on real data, which are collected in the field and not only on statistical information reflecting the uptake and acceptance of the scheme. Saving money on research by using cheap and easy, but inappropriate and untested indicators for quality control actually means wasting money instead of saving – and we will never be able to decide whether the targets of the EBS for 2010 have been met.

The Biodiversity Action Plan on Agriculture and Indicators

Kevin Parris, Policies and Environment Division, Agriculture Directorate, OECD, France

For the information of the colleagues on involved with this e-conference it might be of interest in the context of indicators and monitoring the impacts of agriculture on biodiversity to see the results of the very extensive OECD discussions on this topic at an Expert Meeting in 2001 summarized in a publication, which includes a Summary Report. See the OECD website at: http://www.oecd.org/agr/env/indicators.htm. A key conclusion of this meeting is to take a holistic view of biodiversity related to agriculture, and not to focus exclusively on threatened species and habitats. It is also important to take into account the linkages between farm management practices and systems and their impacts for biodiversity. This is described in the Summary Report mentioned above.

The OECD is currently in the process of compiling information from Member countries, including all EU Member countries, related to the indicators recommended at the 2001 meeting. The results of this work will be published in early 2005.

OECD has also had extensive discussion at an Expert Meeting in Rome in 2003, on developing soil biodiversity indicators for agriculture. The Proceedings of this meeting will be published within the next month, but in the meantime please see the papers at the OECD website at http://www.oecd.org/agr/env/indicators.htm see under What's New and the Soil meeting then you will need the Username: Soil and Password: Italy. Please also note that some of these papers will be slightly revised once published.

Using AES to create a market for biodiversity

Frank Wätzold, UFZ, Germany

In AES, compensation is usually paid when certain measures are carried out. An alternative approach is to pay compensation for results. Under this approach, for instance, compensation would not be paid to a farmer for creating a suitable habitat for an endangered plant but only for the actual presence of the plant on the farmer's field. Such an approach exists only in a few compensation schemes in Europe (e.g. the MEKA II programme in Baden-Württemberg, Germany).

Possible disadvantages of such an approach include high administrative costs for verifying whether the ecological results have actually been achieved and that farmers may demand higher payments than those representing actual conservation costs. The reason is that there is a risk that farmers receive no payment at all as payments do not only depend on farmers' efforts (as in the case of payments for measures) but also on fluctuating exogenous influences such as weather conditions.

However, the big advantage is that a market is being created for biodiversity with a demand for biodiversity as a good. This implies effectiveness of the scheme as only those are remunerated that really provide biodiversity. It also implies that farmers suddenly have an incentive in providing biodiversity in a cost effective manner. If such a market were as effective in providing biodiversity as it has been in providing consumption goods over the last 200 years, biodiversity conservation would make a great leap forward.

The arguments presented here (as well as others) need to be analysed in depth and augmented by a comprehensive analysis of the two alternatives. This would allow a thorough evaluation of compensation payments for results as an innovative and promising alternative to compensation payments for measures.

RE: Using AES to create a market for biodiversity

David Cope, Macaulay Institute, Aberdeen, UK

The idea of paying farmers for biodiversity products rather than techniques is formulated in sound economic principles. However, I would like to suggest that paying for the implementation of techniques is not only logistically easier, but can benefit general biodiversity conservation in the long term in a better way than paying for biodiversity products.

The experience in Scotland of goose management schemes (technically not an Agri-environment scheme) suggests that payments for biodiversity products (in this case greater numbers of geese foraging in farmers' fields) resulted in conflict between the farm managers, and the people who were counting the geese and overseeing the schemes. These schemes therefore moved away from compensatory payments per goose, towards area payments per hectare for positive management actions by farmers. By clearly specifying the required techniques (based on a good scientific understanding of how different management techniques would affect geese), I believe that the farmers involved were generally satisfied, and (at least in one case: Cope et al. 2003) the conservation objectives were generally met.

The move towards area-based payments for the application of certain techniques has therefore reduced conflict between farmers and conservationists, and thus opened up more avenues for dialogue between the two groups, which could lead to further uptake of AES.

Any failure of existing AES that prescribe certain techniques rather than pay for products is more related to prescribing the wrong techniques than the general principle of paying for management techniques. More scientific evidence should be sought to understand which techniques produce the best gains, and possibly more flexibility should be encouraged with AES to allow for adaptive management experimentation to be conducted.

RE: Using AES to create a market for biodiversity

Frank Wätzold, UFZ, Germany

The case study is very interesting and I am fully aware that payments for biodiversity products can not be applied to all species. It is difficult to judge about a case one does not know but it seems intuitively clear that it is difficult to use payments for products in the case of geese conservation. In this case it will certainly be very difficult to relate the ecological result (I assume an increase in the number of geese) to certain actions carried out by a particular farmer. To be able to do this, however, is a precondition for a market for biodiversity products to function. More in economic terms, the geese example may probably be a case where high administrative and monitoring cost provide an argument against payments for biodiversity products (a point raised in my previous contribution). However, there are other species imaginable, e.g. endangered plants, where probably monitoring and transaction costs are lower.

David Cope argues that the problem may not be to have the wrong instrument but to prescribe the wrong techniques. Of course, our knowledge here is far from complete. However, in terms of generating knowledge about conservation techniques, compensation payments for products have two advantages compared to conservation payments for measures. (1) They provide an incentive to the farmer to use his/her local knowledge about plants and animals for the benefit of conservation, because the farmer only gets the payment if the conservation action is successful (our own work with farmers made us aware that farmers often have local knowledge about endangered plants and animals which enables them to develop more effective conservation strategies than biologists). (2) The article by Kleijn et al. in Nature demonstrated very well that what biologist perceive with their best intention and knowledge ex ante as good for species conservation may be wrong ex post. This goes undetected for a long time in the case of payments for measures as here an evaluation usually takes place only in terms of whether the measures are being carried out. By contrast, it will be detected very soon in the case of payments for products as here the evaluation must be focused directly on the results.

Anyway, this discussion probably shows that there is a need for more research on the respective advantages and disadvantages of payments for products and payments for results.

RE: Using AES to create a market for biodiversity

David Cope, Macaulay Institute, Aberdeen, UK

Frank's response to my comment raises a very important point in my mind. I mentioned the fact that flexibility in Agri-environment schemes should be considered to be very important. I would like to think that a nationally-administered scheme could allow room for actions that are of particular relevance to the local level. For example, the presence of a rare plant species on just a few farms could become income generative for those farmers who undertake to protect it and increase the abundance of that species. However, there's no point in providing a particular AES for such a payment at the national or EU level, as it is only of relevance at the very local level.

So, I do not argue against schemes that provide incentives for products, but I do not think that they can be widely applied. Moreover, farmers who are farming in areas with no BAP species, through no fault of their own should not be precluded from improving the general nature value of their land through positive management.

Additionally, by providing general 'methods' payments, the direction of farming can be diverted towards nature/landscape management. In the UK, the 20th Century was dominated by a pressure to ensure a strategic food supply. Now that pressure is being reduced, new incentives need to be developed to encourage farming to turn its attention to the

new agenda under discussion here. I think that payments for practices are the best way to change the 50 year-old tradition of intensification as it can be more inclusive than payments for products.

In summary, while paying for products can be a valuable tool for local action, paying for practices at a wider scale is the best approach for achieving the current goal of halting biodiversity decline by 2010.

Research needs for the Biodiversity Action Plan on Agriculture: Summary of session 2 and introduction to session 3

Tom Bolger, Session chair, Department of Zoology, University College Dublin, Ireland

As researchers, we continue to generate more data, statistics, documents, and declarations than we can possibly absorb. And, rather than investigate new ways to understand and assimilate the existing information, we simply create more, and at an increasingly rapid rate. Thus, we need to examine methods of integrating the wealth of data and information that exists into knowledge which can be accepted and used by managers and policy makers.

This can be difficult because, as E. O. Wilson (1998) pointed out, while we may think intuitively that biology, environmental policy, social science and ethics are closely connected and that rational inquiry in one informs reasoning in the others, each has its own practitioners, language, modes of analysis, and standards of validation. This can often lead to confusion.

Biology is not the only, and probably not the most influential, discipline involved in decision making about biodiversity issues. We, therefore, need to be capable of providing sensible and accessible advice to policy makers and environmental managers. We are inclined to argue that because of complexity and the influence of stochastic effects in ecological systems, it is impossible to give accurate predictions. However, some have argued that this failure of ecologists to explain adequately the uncertainties associated with their advice has diminished their influence on the decision-making process. For example, Al Gore (1992) says that "where science thrives on the unknown, politics is often paralysed by it". We therefore need to develop methods of getting over these difficulties.

"Ecologists who seek to inform policy makers must distil the results of complex analyses that predict uncertain outcomes into simple and clear advice. They therefore face a dilemma: do they present a simplification of the situation that is persuasive but might pay insufficient attention to the reliability of their conclusions; or do they emphasize the uncertainties inherent in their analysis? The first option is likely to result in the caveats associated with the advice being ignored, the second is likely to result in the advice itself being ignored. Even if the advice is accepted, a high degree of uncertainty about the potential outcomes of management actions provides many opportunities for confrontation among different interest groups, and this can hinder the development of consensus" (Harwood and Stokes 2003). The debate about the effects of agriculture on biodiversity is typical of such a situation.

During this week we will discuss these issues which are at the researcher-user interface. Even if the true situation is not as bad as suggested above, we must improve the ways that we provide advice. If we do not provide effective methods of bridging this interface, our research is essentially useless. How can we move things forward? Are our experiments always designed to provide reliable and rigorous results? Do we need further research into experimental design? Do we need further research into methods of integrating our results into proper risk assessments and of developing rigorous methods for evaluating uncertainties? Have we developed adequate methods of rational conflict resolution in such a context?

As pointed out last week by Allan Watt, we need to appreciate the importance of the ongoing discussions and engage actively in them. If we cannot convince policy makers of the value of our research, or if experimental designs lead to ambiguities and unnecessary levels of uncertainty about our conclusions, we may not be able to convince policy makers as to how to improve situations or to avoid management strategies that result in serious and/or irreversible environmental damage.

Research needs on methods of conflict resolution in the implementation of agri-environmental schemes

Rehema White and Rob Brooker, Centre for Ecology and Hydrology, Banchory, UK

SUMMARY: Research needs should focus on prediction, identification and characterisation of conflicts; mechanisms to avoid conflict through appropriate stakeholder analysis, participation and capacity building; development of tools to manage conflicts including comparison of approaches, quantitative and qualitative methods and livelihood analyses.

Agri-environment schemes are dynamic drivers in rural environments and, as with all drivers of change, can cause considerable divergence of opinions within society, either as a consequence of people's inherent resistance to change per se or because of differing goals.

These diverging opinions can have both positive and negative consequences. If the divergence of opinion is not managed there is the potential for debate to spiral into conflict, delaying or restricting the implementation of agri-environment schemes and potentially reducing their ultimate success. Conflicts have arisen especially from the processes of intensification, abandonment and scale of operation of agriculture (Young et al., 2003). However, if divergence of opinion is used to stimulate debate from the outset, this can feed back into the underlying structure or implementation of such schemes, thus avoiding conflict and improving the effectiveness of the schemes. The research needs that we highlight aim at predicting and characterising conflict scenarios, avoiding conflict and effectively managing conflict once it has occurred. This approach would support an adaptive adoption of agri-environment schemes that recognises and respects cultural, socio-economic and biological differences throughout Europe. It should be noted that although we discuss this approach in relation to agri-environment schemes, these research priorities are generic to the European Biodiversity Strategy as a whole. We propose the following research needs:

1. Understanding conflict

Identification of past and existing conflicts

Determination of the long- and short-term drivers of current conflict: economic, social, historical or political.

Characterisation of conflicts in terms of social dynamics to aid selection of management strategy (e.g. Warner, 2000)

Assessment of potential for future conflict in proposed agri-environment schemes and biodiversity strategies

2. Avoiding conflict

Development of an appropriate suite of tools for assessing stakeholder opinion, impacts on livelihoods and the potential for conflict prior to the implementation of agri-environment schemes.

Design of adequate feedback mechanisms from stakeholder interaction into the agri-environment scheme design process, including strengthening fora to foster constructive interaction, developing communication channels and improving knowledge transfer, with feedback to planning occurring at the appropriate scale (local, national or continental).

Measurement of the needs and impacts of capacity building in the form of public awareness and training to enhance understanding of different perspectives

Monitoring and evaluation of stakeholder perceptions and impacts on biodiversity throughout the development and implementation of schemes

3. Dealing with conflict

a) Assessment of the suitability of existing conflict resolution methodologies, including qualitative and quantitative techniques, for dealing with the range and categories of conflicts identified; b) Stakeholder analysis including profiles, positions and power relationships (e.g. Chevalier, 2002) and analysis of approaches (e.g. FAO, 2000); c) Assessment of the uncertainties associated with these techniques and an educational programme highlighting

their strengths and weaknesses to policy makers: d) Assessment of the economic benefits of avoiding conflict. Is it cheaper to invest in conflict avoidance than conflict resolution?

By addressing these issues we will promote a more holistic and socially integrative approach to the design and implementation of agri-environment schemes.

RE: Research needs on methods of conflict resolution in the implementation of agri-environmental schemes

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Mercedes Prado, Public University of Navarre, Spain.

Research on biodiversity should include social conflict resolution approach into the agenda, in an interdisciplinary way. But the approach should be aware that conflict is not something bad per se, but it might be a way to present differences and contradictions in society. Conflict is an important driver of social change. Focusing conflict as something negative or instead as something positive makes a difference for the research agenda, as it has an impact on:

- Epistemological aspects: the creation of knowledge. Even knowledge and the access to knowledge is not equally distributed in society, the creation of knowledge is a collective action (i.e. by research institutions, or by people experience dealing with daily activities which require resolutions).

- Knowledge is collectively constructed; it has a processional character (it is developed in social processes); it is relative (there is not an only and exclusive truth; the collective perspective afford the complementarity of diverse views on the same matter); and it evolves (knowledge changes in time, and new discoveries open new perspectives). For that, contrasting perspectives is crucial.

- Democratic aspects: Knowledge aims to a common and shared goal, collectively negotiated to produce the changes toward a Sustainable Development.

RE: Research needs on methods of conflict resolution in the implementation of agri-environmental schemes

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Klaus Henle , UFZ, Germany

Mercedes Pardo listed an important research topic for biodiversity in agricultural systems. However, I think the approach she suggests is too narrow, focussing mainly on the social/society side of the conflict. We additionally need to understand and manage the ecological side: What is the ecological basis of the conflict? What ecological mitigation strategies exist? What are the ecological consequences of policies and conflict reconciliation strategies? Unless we really integrate human and natural sciences for an analysis of the basis of the conflict and for a development of solutions, we are not making really sufficient progress in dealing with conflicts in agriculture and biodiversity.

RE: Research needs on methods of conflict resolution in the implementation of agri-environmental schemes

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David Gowing, Open University, UK

I support the view of Klaus Henle. I am aware of agri-environment schemes, where differences in opinion concerning their implementation exist within the ecological research community. Whilst this can make for interesting scientific debate, we lack a forum that allows the scientific community to interact effectively with policy makers. The result is that the implementation of these schemes lacks the flexibility to respond to our constantly developing ecological understanding of the systems being managed.

Research Needs on the Design, Analysis and Statistical Power of Studies of the Effects of Agricultural Practices on Biodiversity

Joe Perry and Suzanne Clark, Rothamsted, UK, and **Peter Rothery**, CEH, UK

SUMMARY: There is an urgent need for research on design, analysis and statistical power, to underpin the development of experimental techniques and monitoring methodology to study the effects of agriculture on biodiversity that are cost-effective and efficient.

There is an urgent need for research to develop experimental techniques and monitoring methodology to study the effects of agriculture on biodiversity that are cost-effective and efficient. It is recognised increasingly that to be of relevance for policy, such studies must be at the field or farm scale, rather than the small-plot scale. The use of relatively large scales to study agricultural practices poses new challenges for the generation of efficient experimental designs; these difficulties are compounded when composites of several practices are studied in evaluations of integrated farming systems. Existing studies of the power required to detect reasonable sized effects at the field scale (Perry et al. 2003) showed that considerable replication was necessary, in excess of 60 fields. The resulting study, the Farm Scale Evaluation of GMHT crops (Firbank et al., 2003) is seen as a benchmark for the evaluation of farming practices. It provided data of high-quality, but was very expensive, costing in excess of 1 million €cu per crop. The highest priority for research must be to develop the means to reduce the cost of future similar studies, whilst retaining relevance to policy and rigor of the science. This requires an examination of biometrical issues relating to the design, analysis and statistical power, and biological issues relating to the selection of suitable indicator species. These issues include:

(1) Identification of the relevant spatial scale for choice of experimental unit. Estimation of the size and variability of the units for which the environmental impact is required; estimation of the size and variability of the unit to which the agricultural practice is applied; variability of field and farm sizes both within and between regions and nations; selection of scales for which management practices have been historically uniform and estimates of the duration of uniform practice.

(2) Identification of the appropriate temporal scale for the experiment. Choice of suitable time scale when several taxa of differing generation times are studied; design and analysis of cohort studies; quantification of rotation lengths and composition for arable and mixed cropping; determination of number of repeat samples through time; need to account for possible temporal autocorrelation of samples

(3) Up-scaling from plots through fields to landscapes and regions, and from seasons through years to rotations. Analysis of mathematical models for up-scaling to quantify the errors of assumptions and their progression through multi-parameter models.

(4) The ecological evaluation of effect sizes for power analysis, allowing for the proper distinction between biological and statistical significance.

(5) The development of realistic statistical models for statistical power analysis. The requirement for analysis of small counts arising from sampling rare species of low abundance or high conservation value. Allowance for discrete distributions with large variance heterogeneity often encountered in ecological data. Determination of accurate models for dependence of variance on mean for ecological data.

(6) Development of models for analysis of count data with complex structure (several levels of variation, repeated measures, covariates at different scales).

(7) The elaboration of univariate analyses for autecological studies to multivariate methods for studies of communities and multi-trophic interactions. Agreed protocols for the use of multivariate methods to assess the relationship between species and their environments and statistical and biological significance for community-based studies.

Research needs and support services requirements for biodiversity research in the context of agricultural systems

Liam Lysaght, The Heritage Council of Ireland, Ireland

SUMMARY: The development of an extensive science-based support network is a pre-requisite for meeting the biodiversity objectives of the Agriculture BAP.

The production of the Biodiversity Action Plan for Agriculture marks a significant departure in the way in which conservation (in this instance the conservation of diversity) is dealt with in policy context. The BAP approach is a knowledge based policy instrument, and the challenge of using this to integrate with and influence Common Agricultural Policy, which is primarily driven by economic and social influences, should not be over emphasised.

Existing CAP is supported by a range of advisory services and instruments to assist in the delivery of the policy objectives; market and social drivers work to further assist, or distort, policy objectives as the case may be. A similar support network, but one founded on science and knowledge, is required if biodiversity objectives are to be fully met.

What is the nature of the biodiversity support services required? At the most basic level, by recognising the importance of the ecosystem approach and traditional methods of land management in the agriculture BAP, this requires extensive research on the links between biological diversity and different farming systems at a regional level. The level of knowledge gained must be such as to enable predictions on how these systems respond to policy and other influences at national and pan-European level; it is difficult to see how this could be done without the development of a European typology of farming systems (CEAS & FNCP, 2000).

An agreed set of indicators must be developed that can act as surrogate measures of biological diversity and ecosystem robustness, and track whether policy instruments have the predicted outcome. The indicators should focus, if possible, on the links between agricultural activity and ecosystem function, but recognise the pragmatism required to articulate complexity to the non-scientific community and policy makers.

The research-based agenda must prioritise actions to deliver on current needs and trends, but the agenda should be sufficiently comprehensive, or at least strategic, to cater for the future development of policy initiatives relating to agriculture and biodiversity. Expansion of research on taxonomy, ecosystem function, and the temporal and spatial distribution of organisms at an appropriately large scale are essential. This requires resource allocation to training and education, the creation of efficient data management systems, and harnessing the enormous contribution that the voluntary sector can bring to data collection.

A final research need that could be consider tangential to the Agriculture BAP, but in reality underpins all the efforts, is the need to undertake research on how to promote the need for conservation of biological diversity to an agricultural sector that is largely disinterested, if not downright antagonistic to this message. The retail sector, for example, allocates considerable resources to understanding its target audience; the same principles apply in the conservation sphere.

From knowledge to land use standards outside AES

Rainer Muessner, CIMAR (Centre for Marine and Environmental research), Portugal

SUMMARY: There is an urgent need to improve the ability of the scientific community to integrate the existing knowledge in standards, regulations and mode of operations for different kind of land uses (here: agriculture). A concentration of research initiatives to effects of AES is by far not enough to change general patterns of land use techniques.

This contribution tries to link the central questions of the previous session that focused very much on AES implementation and on one field of the current session, namely the research - user interface. From my point of view the general possibilities to mitigate negative effects of agriculture to biodiversity by means of AES are by far overestimated from nature conservation side. Of course some AES have good results, but looking at the overall picture in agriculture, the AES haven't changed the general operation management of the farms nor their internal structure (Kleijn et al. 2001, Baudoux 2001). AES cover only certain parts of our landscapes, mainly not very productive parts of the farms that would be abandoned anyway. Most farmers see AES as complementary option but not as main business option for farming. Even considering the slightly rising resources for AES and other instruments of the 2. Pillar of CAP, the imbalance will be kept. To establish a real "market" for it and how to do compensation are other problems of AES (see also topic "Using AES to create a market for biodiversity" by F. Waetzold and David Cope.)

Another critical point for the success of AES is the question how well they are adapted to local/regional peculiarities. This "regionalization" is methodological sometimes are very difficult task and therefore I recommend further research in this field to enhance the environmental efficiency of AES. Christian Kleps mentioned in his contribution the very important point of poor agricultural practices that are one of the main reasons for the negative effects of agriculture for Biodiversity. The established instrument to counteract poor agricultural practices (that exist in member states as well as Accession States) are the so called codes of good farming practice throughout the EU. These are the standards that define what is allowed and what is unacceptable and they are some kind of a science – user interface. Technical Standards are scientific data and information transformed in knowledge that can be accepted and used by politicians and managers/farmers (see introduction to session by T. Bolger). These standards combined with tax and market regulations (incentives) from the CAP are the ones that have the capability to change land use techniques and farm structures and not the AES. We are complaining a lot about existing uncertainties due to the complexity of ecosystems, but that should not hinder us to integrate what we already know into some kind of standards, like the state-of-the-art or best-available-technique regulations. In industry and commerce these are legal terms, highly dynamic and very effective in integrating environmentally friendly techniques. But in agriculture these standards are neglected by most conservationists and the research community. Setting standards is a societal process and the regulations of how to do it (i.e. mixed expert groups of agriculture, environmental scientists, agencies and other stakeholders) are known. But science has to play its role in this game, because this is really an integrated approach, like it is postulated in the Cardiff strategy (integration of Biodiversity in sectoral (here agricultural) policies).

I propose the following research needs:

1. How to integrate existing knowledge in agro-ecology in regulations and standards for land use technologies?

2. We need experimental design to give clear advice of negative/positive effects of selected land use techniques (plugging, fertiliser application) and on the environmental effects of different commodities (Clay 2004)

3. Research on trade-offs between environmental effects of selected land use techniques and economic consequences to set reasonable thresholds for the standards.

EU Ultra peripheral zones

Florent Engelmann, CIRAD, France

This is just a short message to remind all of the presence within the EU of the 7 so-called ultra peripheral regions (Azores, Canaries, French Guyana, Guadeloupe, Madeira, Martinique, Réunion). These islands host a large amount of biodiversity which is often highly threatened, notably due to very high anthropogenic pressure in closed island systems. On the other hand, these regions offer tremendous opportunities for research on numerous biodiversity-related topics, as well as for regional collaboration. These regions should not be forgotten when developing our various action plans.

Structural change

Klaus Henle , UFZ Leipzig-Halle, Germany

SUMMARY: Most suggestions made in the e-conference so far regarding research needs in agriculture and biodiversity focussed on the local to regional level. Here I argue that we need a focus more on integrating different levels, especially the supranational level.

Several contributions stressed the need to study the effects of agriculture on biodiversity on a local level using adequate experiments. Likewise, implementations of AES focus on a local level. While I agree that uncertainties and inadequate knowledge exists and that the local level is very important for the implementation of any policy, few ecosystems are as well studied and as easy to manipulate as agricultural systems on the local level. Two major problems with profound effects on biodiversity in agricultural systems are too easily forgotten by taking a local to regional view:

The EU is undergoing major social, political, and economic changes. These will lead to large-scale agricultural changes that simultaneously take place and profoundly affect biodiversity across national borders: structural changes of the landscape, intensification, abandonment, introduction of new technologies, and new transport systems. In the past such changes could be observed each time a new country entered the common market, and sometimes, as when Britain joined, it also had even profound effects on the other side of the world (e.g. in Australia, New Zealand). Thus, certainly major changes will again take place with the enlargement of the EU though it is far from clear how these changes will proceed and what their short- and long-term effects will be from the local to the global level. I miss research that tries to assess, understand, and predict the expected effects on biodiversity and that develops strategies to avoid and mitigate the risks for biodiversity inherent in such processes and to use the changes they provide for the conservation of biodiversity. Research that empowers us to mediate such processes will be of tremendous importance for European biodiversity.

Similarly, the EU is involved in major global trait negotiations, e.g. within WTO. Decisions on this level also have major influence on biodiversity, and not only in Europe but globally. E.g., the liberalization of the sugar market will lead to a reduction of sugar beet production in some European regions and to a collapse of sugar cane production in Australia to the benefit of Brazilian sugar plantations. Thus, trait negotiations have tremendous implications, both beneficial and adverse, for biodiversity. Concerted research programs developed jointly by the EU and other regions of the world are needed to address and mediate the effects of such trade agreements.

Research needs in both the old and the new EU

András Báldi, Hungarian Natural History Museum and **Martin Dieterich**, Dieterich, Beinlich & Partner Consultants, Board Members of the Society for Conservation Biology - European Section

For centuries or even millennia agricultural land has covered a vast proportion of most European countries. The management of these areas is crucial for the conservation of biodiversity. The EU Common Agricultural Policy (CAP) has so far focused on increased productivity of the agricultural sector. In most areas it has caused a significant decline in biodiversity. While the current direction of agricultural policy is changing from production-related to area-related subsidies, and while cross compliance is introduced as an important element to obtain funds, the effects of these changes are unclear even for the former EU member states. Standards for cross compliances in terms of good ecological practice are yet to be defined (Annex IV, EU 1782/2003).

The EU enlargement in Central and Eastern Europe will add 738,000 km^2 (and 75 million people) to the EU. Large parts of these areas are still extensively managed in a traditional way and are rich in natural values. After the enlargement, the CAP will cover these as well. Small-scale and extensive traditional farming is likely to be particularly threatened. Yet, its maintenance is crucial from a biodiversity conservation standpoint. Does the CAP have the necessary knowledge? According to a recent review by Kleijn and Sutherland (2003) on the effects of agri-environmental schemes in Europe our scientifically sound knowledge is almost zero.

In this light it is strange to read in the Biodiversity Action Plan for the conservation of natural resources on page 17 that the CAP will undoubtedly contribute to enhancing the conservation of biodiversity. This is not true. CAP may contribute to the conservation of biodiversity, but at the moment there is no reliable basis for this. There is some hope for the CEECs that agri-environmental schemes will contribute to the conservation of the still diverse farmland biota, because it seems that this biota is highly sensitive to management intensity. Verhulst et al. (2004) found that in Hungarian grasslands ("puszta") and vineyards the diversity and abundance of most bird species declined sharply from extensively managed to intensively managed areas. Responses in other taxa (plants, grasshoppers, pollinators, and spiders) are currently investigated (more at: http://www.dow.wau.nl/natcons/NP/EASY/). However, this covers only a very small part of ecosystems in the CEECs, where CAP will govern agriculture within days.

It is clear that agri-environment schemes need to play a more prominent role within the agriculture-related funding system and primarily target biodiversity conservation. And rather than focusing on restrictions to be compensated for, agri-environment schemes will have to focus on actual success in terms of biodiversity. For example, provision of funds for species richness in grasslands through the MEKA scheme in south Germany was hampered by the EU restrictions, which stated that independent of success, funds can only be claimed if the first cut was not used for silage. A more target-oriented approach needs closer, and more scientific rather than administrative, monitoring of success. It needs freedom to develop local approaches and provide farmers with sufficient latitude to operate. Again, more freedom to operate will require support by conservation biologists and well-trained project officers.

Biological processes in agriculture

Zdenek Stehno, Research Institute of Crop Production, Ruzyne, Czech Republic

In agriculture that works with living organisms most processes have biological character. Biological processes are complex and result in traits and properties important for utilisation of agricultural products. During their growth, plants, including crops, are influenced by stochastic effects and final phenotypes are the result of realisation of genetic information under specific conditions. Nevertheless, correct experimental design and utilisation of proper biometrical methods strongly reduce uncertainty of results or at least identify their significance level. Unfortunately, sometimes, the use of modern biometrical methods is underestimated and in some cases improper methods are used. Experimental designs are under continuous development with the aim to obtain more precise results useable in further steps of research, breeding and agricultural practise. Experiments examining partial processes such as DNA transcription, protein synthesis, assimilate transfer etc. usually provide more precise results than evaluation of complex characters such as morphological traits, product quality, yield potential etc. From this point of view further development of experimental design and methods of results' assessment seems to be important. Reduction of experimental results' uncertainty is important for policy makers as well as other users (researchers, breeders, teachers).

Assessment of the influence of agriculture on biodiversity is a very complex issue. Because agriculture is an important user of biodiversity, it takes measurements to maintain biodiversity as wide as possible (up to now mainly biodiversity usable for agriculture). Plant genetic resources are maintained ex situ (gene banks) to be available for use in research, breeding or direct growing (e.g. landraces) in future. Monitoring of crop wild relatives takes place and their maintenance in situ is supported. Also duplicate maintenance of in situ conserved accessions in ex situ collections is under development.

Research needs for the Biodiversity Action Plan on Agriculture: Final comments

Tom Bolger, Session chair, Department of Zoology, University College Dublin, Ireland

At the opening of this e-conference I suggested that we should discuss whether we had an adequate knowledge of the major agricultural drivers of biodiversity loss; whether the drivers were the same throughout Europe; whether we were sure that the agri-environmental schemes being introduced would have beneficial effects; and whether we knew enough about the resolution of potential conflicts which might arise through the implementation of these schemes? I think that it is safe to say that all contributors have suggested that the answer to all of these questions is NO.

However, we still have not come up with any unifying research agenda for the future. For example, over the weeks of the e-conference many people have provided examples that suggest that we need to consider effects at local levels. However, recently, Klaus Henle has provided similarly convincing arguments for considering things at a continental scale. Which should be prioritised?

While very few contributors dealt with specific agricultural drivers of biodiversity, several have commented at the need to carry out our research at appropriate temporal and spatial scales. This idea was returned to consistently from Gordon Purvis' contribution on the first days to Joe Perry's discussion of experimental design during last week. Do we need any further plot scale experiments, is it now time to concentrate all of our efforts at larger scales? Another theme, which appeared on a number of occasions, was whether the focus of agri-environment schemes should be on a process (e.g. area aid) or a product (e.g. the presence of a particular species on a farm). This seems to me to be reminiscent of the Ehrlich/ Walker debate on important species and which species/habitats/features need to be encouraged. Indeed, the idea was almost framed in that context by Richard Ferris in one of the other sessions. Do we know enough to make those decisions?

Nobody believed that we knew enough about any agri-environmental scheme. What specific research is needed there?

Virtually everybody who wrote on policy or knowledge issues commented on the need for effective communication. This arose in terms of conflict resolution, the value of conflict in terms of knowledge generation, the promotion of our ideas etc. Do we have appropriate fora for such communication or do you agree with David Gowing that we lack a forum which allows the scientific community to interact effectively with policy makers? Do we need, as suggested by Liam Lysaght, to allocate resources to understanding our target audience, as does the retail sector?

Finally, I have been surprised by the general lack of comment on the need for taxonomic research and support for taxonomic research infrastructure (e.g. museums, record centres etc). Is this an oversight or a reflection of our feelings?

Biodiversity Action Plan- Conservation of Natural Resources

Research needs for the Biodiversity Action Plan on the Conservation of Natural Resources: opening comments

Tiiu Kull, Session chair, Institute of Zoology and Botany, Estonian Agricultural University, Estonia

The objective of Biodiversity Action Plan (BAP) is to restore, maintain and improve the favourable conservation status of natural habitats and species of wild fauna and flora. Among other tasks, reversing the current trends of biodiversity loss related to management of water resources, soils, forests and wetlands is prioritised. To achieve this, several specific measures are planned: To implement Habitats Directive, as well as the Birds Directive; To support the establishment of network of protected areas, particularly the EU Natura 2000 network, and to provide adequate financial and technical support for their conservation and sustainable use; To develop management plans for selected threatened species and some hunted species; To use the Water Framework Directive as a tool for conservation and sustainable use of biodiversity and in this context to develop analyses of water quantity and quality versus demand (including agricultural irrigation, energy generation, drinking and ecological uses) for every river basin; To enhance the ecological function of land cover, including riparian and alluvial vegetation, to combat erosion and maintain the water cycle supporting ecosystems and habitats important for biodiversity; To protect wetlands within the community and restore the ecological character of degraded wetlands.

This session will address the research needs for the achievement of BAP objectives, for monitoring the success of above-mentioned measures, and for proposing new measures. During the next three weeks we have the possibility to discuss whether we know what and how to preserve within the enlarged Europe, and where the balance is in conservation and harvesting of natural resources.

The first session (week) will focus on: What to preserve? Do we know the genetic diversity of species in NATURA 2000 lists? The lists themselves are largely political rather than biological. For making relevant lists we need to know the distribution of species, changes in species abundance and their genetic variability. To find classifications of habitats of different countries has been a real neck-breaking effort, and several specific and threatened types are still out of the scope of the Habitats directive. What should be local versus regional versus global importance of protection of certain species or habitats?

This section will discuss research needs for the: Selection of protected species; Selection of protected habitats; Prioritisation of protected species; Prioritisation of protected habitats; Estimation of the different levels (from local to global) of importance of protection of species or habitats

RE: Research needs for the Biodiversity Action Plan on the Conservation of Natural Resources: opening comments

Richard Ferris, JNCC, UK

Many Species Action Plans = confusion and management conflicts. A solution might be to have more grouped plans, putting together species according to feeding ecology, for example: e.g. woodland seed-eating birds.

Given the importance of maintaining and enhancing ecological functions, perhaps we could take a more radical route and develop functional/process-related Action Plans? By this, I am thinking of such things as a grazing action plan, deadwood action plan, eutrophication action plan, etc.

Would such an approach help reduce the apparent burden upon practitioners, plus satisfy the need for a more joined-up approach applicable across a range of spatial scales?

Research needs for the Biodiversity Action Plan on the Conservation of Natural Resources

Bogdan Jaroszewicz, Bialowieza national park, Poland & **Bogumila Jedrzejewska**, Mammal Research Institute, Polish Academy of Sciences, Poland

SUMMARY: The BAP on the Conservation of Natural Resources focuses on wild plant and animal species and their related ecosystems and habitats. This definition points to the importance of knowledge about biodiversity and its relationship to stability/sustainability of ecosystems. Changes in biodiversity will have significant impact on the functioning of the whole biosphere and on the services it provides. Impacts of these changes will have long-term socio-economic consequences. We still do not know how resistant our biosphere is to human-caused changes in biodiversity, how deeply it is already affected. What can we do to stop biodiversity loss and what we must we do to survive? There are still many gaps in our knowledge about diversity of the all levels and fields related to them.

To answer questions considering conservation of natural resources we must learn about what we really do have and what we know about them. The first step should be simple inventorying of our biodiversity and preparation of catalogues of living organisms for each region or biota. This will require a lot of taxonomic work. The worst situation is in the field of genetic diversity, which declines with unknown speed and unknown consequences. On the other hand, we need to identify and monitor alien invasive organisms and to build databases to anticipate the introduction of harmful alien organisms.

However, it is not possible to prepare management plans for each single species; we must apply the umbrella-species and ecosystem approach. Inventories of diversity would provide a good basis for choice of the most important, threatened elements to protect. Some of these elements had already extinct. What about habitat rehabilitation by reintroduction of the extinct species? What is the influence on the ecosystem of the reintroduced species, especially if specimens with not native genotypes are used? From this point of view, it would be very important to establish national programs on conservation of genetic diversity to carry out key studies on the genetic variation and specificity of local populations of endangered or rare organisms, or organisms of significance for habitat rehabilitation.

The problem with conservation of natural resources is much more complicated than it looks - we still do not have good methods of risk assessment and risk management. We still do not know how to evaluate biodiversity damage. We must also take into consideration difficulties in estimating biodiversity changes over 10, 20 (or more) year periods. Another problem is connected to estimating the role played by the species in ecosystem: so called "ecological extinction" or over-domination. This problem is very difficult, because we have lost undisturbed places, where studies of the natural species proportions could be carried out. We are using more or less arbitrary estimates of "ecological carrying capacity", but rarely know what the "natural" carrying capacity of ecosystems is.

Our world is changing very fast. For this reason there is need to develop good monitoring indicators for annual reporting at the global, regional and national levels. They should allow us to estimate impact of climatic changes, ozone depletion and other important factors. Are we prepared to manage our diversity in the context of these rapid changes? Do we have proper tools and methods to save our natural resources facing global warming?

Selecting threatened plants

Sandra Knapp, Department of Botany, The Natural History Museum, London, UK.

SUMMARY: The Biodiversity Action Plan for the Conservation of Natural Resources is silent on the subject of selecting threatened plants, or indeed on the subject of the conservation of plant species at all. Although botanic gardens are recognized as important factors in the ex situ conservation of biological diversity, the focus in the BAP is on habitat – only one of the strands of biodiversity of interest to conservation. This may sound overly negative, but instead it serves to focus the agenda for research on plants, the basis for ecosystems and the source of primary productivity on Earth. Here I will focus on only a few research needs; there are many others, and synthesis is critical for achieving the 2010 target of a significant reduction in biodiversity loss.

In order to select threatened plants for conservation we first need to know what plant species we have and where they are distributed. In Europe we are fortunate in having Flora Europaea (FE, Tutin et al.), a comprehensive taxonomic reference work. Despite the existence of such a reference however, taxonomic work on European plants is not finished business – new species and populations continue to be discovered (e.g. Vladimirov, 2003).

Species richness of plants can be mapped (Humphries et al., 1999, Fig. 1) using these data, as can endemism (Fig. 2).

Figure 1. Species richness of seed plants in Europe. Adapted from Humphries CJ et al. 1999; WORLDMAP image reproduced with permission.

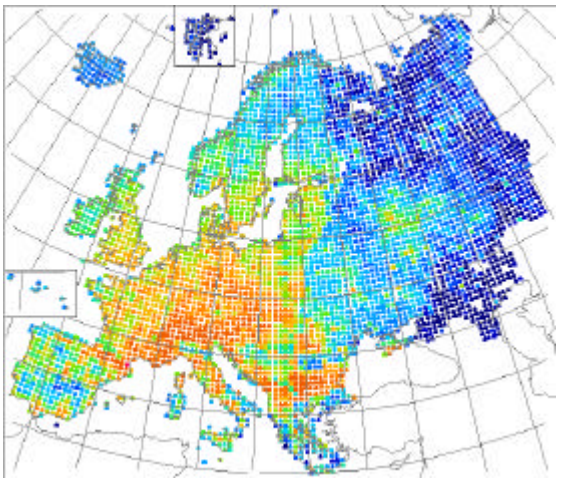
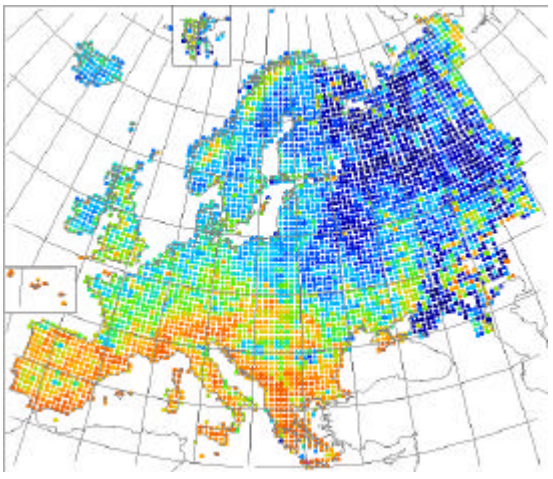


Figure 2. Endemism (range size rarity) of seed plants in Europe. Adapted from Humphries CJ et al. 1999; WORLDMAP image reproduced with permission.



What we need now is to be able to harness the temporal data held in the herbaria of Europe that will allow us to use these same algorithms to quantify the changing state of plant distribution in Europe, as has been done for butterflies (Parmesan et al., 1999) and more locally for several taxa in Britain (Thomas et al., 2004). This will necessitate more research on the development of algorithms and on ways of quantifying the uncertainty inherent in data such as that from herbarium sheets. Investment will also need to be made in additional manpower to capture and provide access to data sourced from Europe's specimen collections.

These data on plant species richness and endemism can be used to assess whether the Natura 2000 sites are really protecting a significant number of Europe's plant species, we currently just do not know. Research is also needed into the distribution of morphological characters in Europe's plant species – linking this to knowledge about the genetic diversity in

European plants will allow us to assess plant phylogenetic richness in Europe and to prioritise the selection of plant species based on phylogenetic uniqueness – a sort of genetic endemism. We also need to quantify threat – how else can we define a threatened species? Assessing threats will require research into the links between distribution, both at the population and species level, and human alteration of the habitat – including climate change. The research needs identified above should include a quantification of the actual and potential threats facing plant species and habitats. Selecting threatened plants can only be done with knowledge about both species and threats!

Last, but not least, research for conservation must be conducted in a framework that ensures fit for purpose, such as that proposed by the UK's Royal Society (Royal Society, 2003). Selecting threatened plants is no exception.

RE: Selecting threatened plants

Miguel Segur, COITF, Madrid

I agree with Ms. Knapp's statement: synthesis is critical. In what I read from you, I see that GIS-related needs exist, but I also feel that there is a trend to overdrive monitoring and progress indicators: of course a European monitoring system is needed, of course there's a need for hands-on research (focused on development as I understand), but I also think that global matters need to be addressed by European researchers. I also see a need of definition regarding the political boundaries of the scope of work. Maybe global perspective is the only one needed, but that implies a series of political options that need to be addressed. Today's research needs about the BAP should also include budgetary prospections.

Research needs for the Biodiversity Action Plan on the Conservation of Natural Resources: Summary of Session 1 and introduction to session 2.

Tiiu Kull, Session chair, Institute of Zoology and Botany, Estonian Agricultural University, Estonia

Bogdan Jaroszewicz and Bogumila Jedrzejewska drew attention to the important fact that knowledge about the resistance of our biosphere to human-caused changes in biodiversity and current status was still poor. They asked for a simple inventorying of biodiversity, particularly with regards to genetic diversity. This would of course provide us with additional information on status and trends of biodiversity but also help in identifying the species needing higher conservation needs. Other research needs included: the identification and monitoring of alien invasive organisms; development of risk assessment and risk management methods; effects of reintroduced species; determining carrying capacities; monitoring the impact of climatic change and other global scale phenomenon.

In her contribution, Sandra Knapp focussed on research needs for selecting threatened plants and pin-pointed the following: taxonomic research to identify the range and location of plant species; development of algorithms and methods to quantify data uncertainty; research on the distribution of morphological characters in European plant species; research to quantify actual and potential threats to plant species (including climate change).

Miguel Segur agreed with Sandra Knapp's contribution and added that a global perspective needed to be adopted by European researchers, implying that political options would have to be addressed.

The coming week gives us the possibility to discuss **How to preserve?**

This section will discuss research needs for:

- Selection of means for protection of species and habitats
- Estimation of effect of habitat management on target species
- Prioritisation of habitat management vs. species protection – is there any difference and if there are, how do we decide which one to choose
- Applicability of population-biological data in conservation practice
- Effective, efficient, and sustainable restoration of (eco-?) biological communities

Research needs for the Biodiversity Action Plan on the Conservation of Natural Resources: the implementation of the Habitats and Birds Directives

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Herwig Unnerstall, Centre for Environmental Research, Leipzig, Germany

In the following remarks I concentrate on questions dealing with the implementation of the Habitats and the Birds Directive. They are rather meant to stimulate discussions than to provide final conclusions:

1) For the successful implementation of the Habitats Directive and the Birds Directive the Member States shall designate the sites of Community importance (once selected by the Commission) as special areas of conservation. The Member States shall establish management plans for these areas, including monitoring systems, criteria for the assessment of the conservations status and rules for economic, agricultural and forestry activities in the area. As the selection of sites as sites of Community importance happened or should have happened in both stages (I and II) without regard to the socio-economic situation of the sites, these aspects have to be taken into account for the adequate (legal) form of the management plans. For these implementation and management tasks imposed by the Habitats directive it would be very helpful to develop modelling tools for the sites that integrate the ecological aspects especially with regard to the site's conservation objectives, the indicators for the local economy and juridical restrictions imposed by the Habitats or the Birds Directive. To build up this type of integrated models is a crucial task of future research.

2) The integration of economic aspects is also crucial for the application of the derogation clause in Art. 6(4) Habitats Directive that requires a weighing up of economic and ecological concerns in the light of the precautionary principle and the overarching objective "sustainable development" embodied in the European Treaties. The Commission in its guidance document to Art 6(3) and (4) has not recognized these aspects adequately. The emerging concepts for a sustainability impact assessment should be reviewed, whether they are applicable in this context.

3) The possible use of the newly structured CAP for the effective implementation of the Natura 2000 network and for conflict reconciliation with agricultural or other owner interests at the sites affected should be investigated. It is also necessary to develop new instruments on a European level beyond individual compensation for farmers or landowners, beyond structural funds subsidizing infrastructural projects or establishment of industries, instruments that are intended to compensate spatial external effects due to restrictions to economic development of a region by nature conservation necessities. To develop new compensation tools is also required, as the CAP is due to the WTO process and the detrimental economic effects and effects on and biodiversity outside Europe in the long run an instrument of decreasing importance.

RE: Research needs for the Biodiversity Action Plan on the Conservation of Natural Resources: the implementation of the Habitats and Birds Directives

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Ola Broberg, Johan Rova and Henrick Blank, Departments of environmental monitoring and nature conservation, County administrative board of Jönköping, Sweden

In Sweden the need for restoring biodiversity has been recognized for a long time by NGOs and partly by environmental authorities. However, this need has rarely been prioritised by the government and only in a few cases been translated into restorations in objects of major national interest. Now with the implementation of EU directives we as a country are forced to reach environmental quality objectives. The directives we have in mind are e.g. the water framework directive (2000/60/EC), the habitats directive (92/43/EEC) and the birds directive (79/409/EEC). To reach the environmental quality objectives that the directives require,

restorations of habitats of many kinds are absolutely necessary. In our county numerous objects already need restorations and in a perspective of 20 years the list becomes much longer. From our perspective, restorations of rivers, lakes and wetlands are especially urgent. For us the need for restoring biodiversity is clear, and with the directives mentioned above this need should also be clear to decision makers and stakeholders. Unfortunately that is not the case today. We hope that this effort will put ecological restoration higher on the EU agenda.

Research needs for developing effective restoration and management techniques

Katalin Török, Ministry for Environment and Water, Bureau for Nature Conservation, Budapest, Hungary

SUMMARY: Research should focus on selecting, designing and testing restoration and management techniques that help to rehabilitate disturbed ecosystems or to restore damaged, derelict territories. The development of restoration methodologies is a requirement of the CBD, however, not sufficiently well covered so far. The same is true for the BAP Conservation of natural resources, that mentions restoration but the know how is not sufficient. Three research areas are suggested to focus on in the coming years to support restoration success for European scale environmental issues: (i) rehabilitation of ecological corridors, (ii) afforestation of catchments and (iii) decrease of invasive plant impact.

1. Rehabilitation of ecological corridors in the Ecological Network system

The NATURA 2000 sites are designated and the ecological corridors that link these important habitats are designed for all member states (or will be done in the near future). The corridors are more a concept and exist mainly on maps as a possibility to link the biota of the sites. The destructive effect of fragmentation of the habitats could be remedied by improving the natural state of the corridors. The task is to develop methods to increase the capacity of corridors, use indicators to assess this capacity. Focus on the most important habitat types of the Habitat Directive. Execute experiments to test the feasibility and the efficacy of management methods. The scenarios of climate change should be taken into account while designing target ecosystems.

2. Afforestation by native species to decrease flood risk in European catchments

Recent floods have demonstrated how human activities, namely deforestation, can influence and increase the risk of devastating floods. A catchment approach is required to handle this problem. The involvement of non-member states is encouraged according to catchment areas. Remote sensing should help to define areas of major flood risk and those of buffer zones. Research should reveal present management practice and design new ones to support the target of biodiversity conservation and flood defence at the same time. The areas of study should include the upper catchment and the floodplain as well. Targeted experiments should test the feasibility of afforestation options. Research has to handle the problem of native tree species propagate availability and market supply.

3. Develop methods to decrease the impact of invasive plants

There are a few plant species that are responsible for major ecosystem disturbance caused by invasion in different biomes of Europe. Previous studies have focused on the description of the invasion process, monitoring and research on their effects. The threat of invasion cannot be handled without the active management of infected territories. Besides decreasing the risk of further invasions, techniques to handle the populations of invasive species have to be developed for the most noxious plants. Mechanical, biological and other manipulative control methods should be tested for the major biogeographical zones.

Habitat management for target species (moving away from a species-based approach to looking at the environment in which the species live)

Richard Ferris and Ant Maddock, Biodiversity Information Service, The Joint Nature Conservation Committee, Peterborough, UK

SUMMARY: With limited resources and the need for a more unified approach to conserving species, a habitat-based approach can offer new and exciting research opportunities and challenges, taking into account the community and functional links between species and the spatial context of their habitats.

- Why habitat management? Analyses of threats to biodiversity consistently point to habitat loss/degradation as the key factor affecting declines in species populations (e.g. WCMC estimates suggest that approximately one-third of all global animal extinctions since 1600 have resulted from habitat destruction (WCMC, 1992); more than 80% of bird, mammal, or plant species were reported as threatened by habitat loss/degradation in the 2000 IUCN Red List of Threatened Species (Hilton-Taylor, 2000); the 2002 reporting round for the UK Biodiversity Action Plan found that habitat loss/degradation was the key factor limiting progress with 61% (n=324) of individual Species/Habitat Action Plans- in comparison, the second and third most important factors, pollution and intrinsic factors accounted for 16% and 7% respectively (JNCC, 2002).

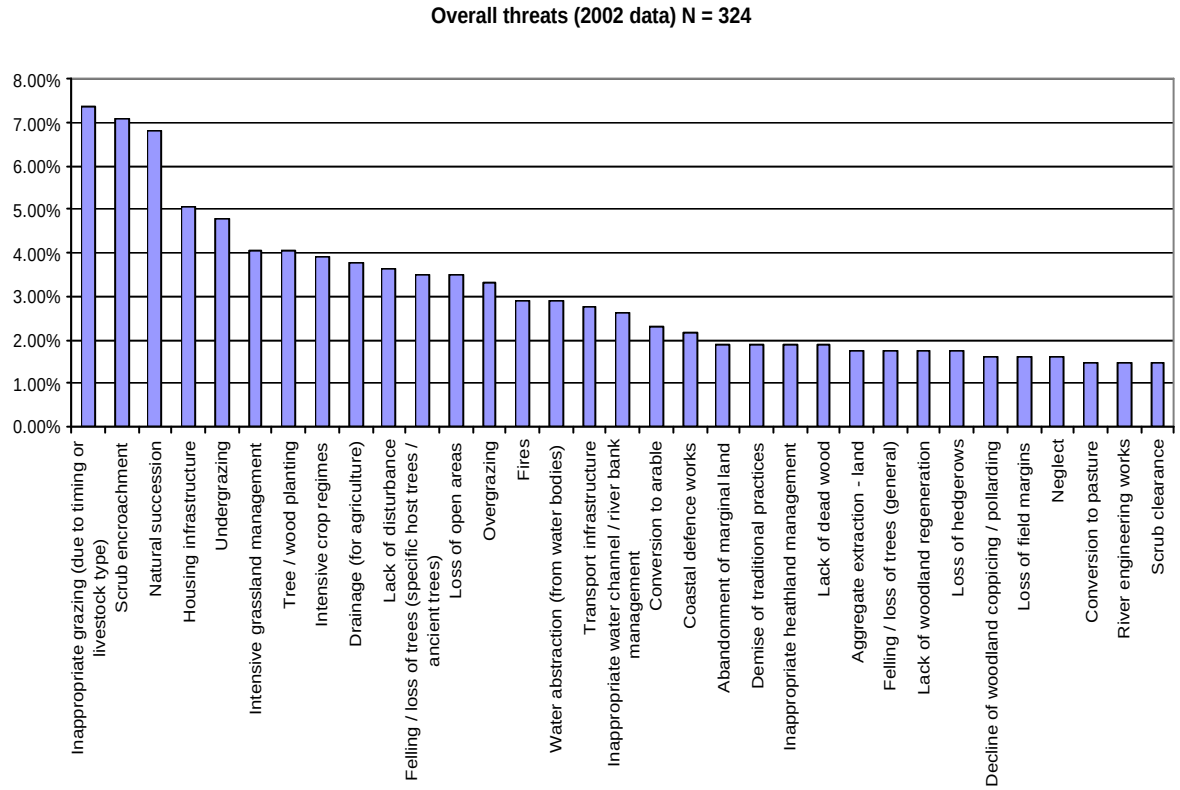
- From species plans to habitat plans: This brings into question the efficacy of individual Species Action Plans (SAPs). Are these the most suitable means for conserving European biodiversity? Should we look to conserve species in a more efficient manner through habitat management? (This is certainly important for more sedentary, exacting species such as saproxylic lichens). Evidence suggests that a large number of individual SAPs, addressing very specific needs, are not cost-effective. This approach can lead to conflicting management requirements, leading to impossible choices for practitioners, and results in a fragmented research community, each team working in isolation and failing to appreciate the bigger picture.

- A community approach? If we accept this argument, do we know enough about techniques for managing different habitats to optimise species conservation, when autecological needs may be very specific? Should we direct research into conservation strategies that address communities rather than species, these communities being defined by the broad habitats in which they occur? (E.g. a BAP for bird communities of broadleaved deciduous woodland; or a BAP for plant communities of thermo-Atlantic xerophytic habitats). Such an approach could be further refined to take into account particular feeding or functional niches (e.g. a BAP for seed-eating birds; or a BAP for succulent plants, respectively). Research could usefully be geared towards understanding the generic habitat requirements of these community types. It would be helpful to tackle the underlying issues, possibly through functional Action Plans, e.g. for grazing, deadwood, etc. This would ensure cross-taxon conservation.

- Managing habitats to conserve species: It is unlikely that we need more research concerned with management practices, since humans have been managing a wide range of habitats across Europe for centuries, and much is known about the co-evolution of species and communities in response to habitat conditions. However, results of current research need to be disseminated to practitioners more efficiently. Research efforts could be usefully directed into providing a synthesis of management practices. The erosion and fragmentation of habitats in the landscape present a number of key research issues, requiring us to improve understanding of metapopulation dynamics (e.g. effective habitat patch size to support sustainable populations; habitat quality and resilience to perturbations; spatial bottlenecks to geneflow). In order to enhance the ecological function of landscapes, e.g. through the establishment of sustainable habitat networks (e.g. Natura 2000), research is needed to convert theory into practice. Do these networks actually deliver effective species conservation?

We need to consider Natura 2000 sites embedded into the wider countryside, the sites acting as nodes, from which impacts radiate out into the surrounding matrix. This would conserve habitats and communities, thereby conserving species more effectively. This would not only address today's threatened species but would slow the decline of common species, preventing them from becoming tomorrow's threatened species. This is especially important in view of climate change scenarios. Thomas et al. (2004) have shown that for many species, climate change poses a greater threat to their survival than the destruction of their natural habitat. Site-based habitat management needs to be resilient to ensure sufficient buffering against climate change impacts. If we move away from a species-by-species approach, can we ensure that habitats are maintained within sufficiently robust limits to minimise risks to species and communities? Will we need to realign the criteria by which we assess habitat condition? What role might be played in species survival by sub-optimal or alternative habitats/refugia?

APPENDIX: Threats to Habitat and Species Action Plan targets within the UK BAP, for the 2002 Reporting Round



RE: Habitat management for target species

Johan Rova, National Parks and Protected Areas Manager, Jönköping County Administrative Board, Sweden

Sweden faces a dramatic loss of biodiversity in the traditional farmland landscape within the next decades. Fennoscandian lowland species-rich dry to mesic grasslands are considered to be the floristically most species rich habitats per square meter on this planet. Connected to the high botanic diversity, a considerable amount of butterflies and other invertebrates are also found in these habitats. But extension of these grasslands has decreased dramatically during the last century, as farming has become more and more intensive.

In a perspective of 10-20 years, restoration of large grassland areas will most likely be necessary in order to implement the habitats directive [92/43/EEC] and national goals for preservation of species in the Fennoscandian grasslands. And this will be true for grasslands that are part of governmentally protected areas as well as non-protected areas.

Management of these habitats are to a considerable extent performed by elderly farmers and NGOs. When new generations take over, these habitats are often abandoned by the farmers because of the small size of the areas and their low economic value. The botanically extremely rich meadow soon turns into shrub land, and is in some cases even turned into spruce plantation.

The largest problem in preserving biodiversity in these habitats will be to find resources for management of the areas. Grazing with few animals in poor grasslands, often far away from the farm, does not yield sufficient income. The animals also need to be looked after daily, which is time consuming. In order to secure the biodiversity, it is extremely important that sufficient funding is raised for management of these areas. Politicians must, to a larger extent than today, realize their responsibility to protect biodiversity in lowland species-rich to mesic grasslands, and address funding to farmers and managers in these areas. If not, Europe will no longer hold one of the most species rich habitats on earth.

Research on social science approaches

Susanne Stoll-Kleemann, Department of Political and Social Sciences, Free University of Berlin, Germany

SUMMARY: This short keynote contribution addresses and explains the need to focus research for Biodiversity Action Plans on the Conservation of Natural Resources on social science approaches stemming from Sociology, Social Psychology and Anthropology.

Given that human activity is the primary driver of biodiversity change, the effective creation and implementation of Biodiversity Action Plans needs to be based on research which focuses on understanding how individuals and social networks value, use and "own" natural resources. Most international conventions, national policies and local regulatory experience have not resulted in the efficient conservation of natural resources. To avoid these pitfalls, Biodiversity Action Plans should adopt social science based research which investigates how such agreements can recognise and respond to the underlying motivations of individuals, social groups, and political processes (see below).

There has been considerable progress in understanding the primary mechanisms leading to ecosystem degradation and biodiversity change such as habitat fragmentation, pollution, invasive species, as well as the effects of such change on ecosystem functions, goods and services. But incorporating such values into strategies which provide incentives for the sustainable use of biodiversity such as Biodiversity Action Plans requires the integration of the social sciences. The German Advisory Council on Global Change points out that "evaluation of the effectiveness of protective and management efforts has been neglected up to now. There is a lack of detailed studies on the effects of nature conservation areas (…) the solution of current problems in the connection with acceptance of and conflicts in protected areas, behavioural and social science linkages need to be recognised and taken into account" (WBGU, 2001, 368). These remarks focus mainly on the better integration of social sciences such as Sociology, Anthropology and (Social) Psychology in interdisciplinary research projects on natural resources management, because these disciplines are underrepresented in biodiversity research (where economic research is more common). These disciplines focus on research into exploring perceptions, values and attitudes of local people towards conservation of natural resources. Examples for this kind of research which would be useful to support the implementation of Biodiversity Action Plans can be found in Stoll-Kleemann 2001a & b; O`Riordan & Stoll-Kleemann 2002 and Stoll-Kleemann & O`Riordan 2002 where sociological and social-psychological approaches have been considered, and where the argument is made for even more integration of these perspectives.

The new Science Plan of DIVERSITAS – the new international global change research programme on biodiversity – also emphasises in its core project 3 "bioSUSTAINABILITY" that the following research issues need special attention: Evaluating the effectiveness of current measures for the conservation of natural resources; how can the success of actions to conserve natural resources be measured; what are the roles of formal and informal institutions, and their interactions in conservation and decision-making with multiple stakeholder groups about the conservation of natural resources (DIVERSITAS 2002). Both, DIVERSITAS and the German Advisory Council on Global Change emphasise the importance of evaluating existing conservation efforts. But this also means that it is necessary to define indicators for the assessment and possibly also for a successful socio-economic monitoring of the conservation of natural resources. Recently the UNBESCO MAB programme BRIM (Biosphere Reserves Integrated Monitoring) has launched a social monitoring initiative, based upon conceptual outlines and implementation rules for pilot areas selected from the World Network of Biosphere Reserves (Lass & Reusswig 2002). This research field is just in its beginning stages, as Hockings et al. 2000 point out in relation to protected areas: „though there have been several calls for comprehensive protected area evaluation systems, few protected area management agencies have implemented such

systems. (…) Those few concentrate on biological conditions and cannot be regarded as comprehensive assessments of management“ (Hockings et al. 2000, 7). Furthermore less attention has been paid to the state of biodiversity management at regional and global scales (ibid).

In order to fulfil these research needs it is vitally important to continue to implement ‘real’ interdisciplinary research efforts including both, natural and social scientists. All too often the required collaboration only takes place on paper. In the same spirit a better integration and combination of complementary methods would promise innovation as well as strong and comprehensive stakeholder integration into the totality of the research project cycle.

Monitoring habitat quality in protected areas

Peter Bliss and Robin Moritz, Institute of Zoology, Martin-Luther-Universität Halle-Wittenberg, Germany

SUMMARY: A focus on developing functional key species, which may serve as biodiversity drivers for local/regional scale monitoring, is needed.

The concept of the habitat is widely used as a convenient unit for site selection for conservation (Southwood, 1977). Extensions of the density-dependent habitat selection theory demonstrate how differences between habitats can modify overall population size (Morris, 1995). Obviously the quality of a habitat is important for the accommodation of any given species. For conserving biodiversity where entire biocoenoses are at stake, habitat quality is clearly a multidimensional property not easily perceived. As a consequence 'habitat quality' is used very differently by different people, often ill-defined and seldom in the context of biodiversity conservation. Nevertheless, the idea of the relative wildlife value of a site is important for conservation strategies (Ratcliffe, 1977, Ratcliffe, 1986).

Habitat quality is based on a set of complex parameters including diversity, area, naturalness, rarity, fragility, typicality, recorded history, position in an ecological/geographical unit, potential value, and intrinsic appeal. Some of these can be accurately measured, others are more difficult to monitor. Some directly relate to biodiversity conservation (e.g., diversity, typicality) others less so (e.g. intrinsic appeal).

In Europe protected areas are either smaller and/or less intensively protected than we hope them to be for the conservation of indigenous biodiversity. Typically, National Parks receive the highest degree of protection but are small in scale from an ecological point of view. Since we cannot monitor each and every species in a given habitat, we inevitably have to make a selection of organisms to monitor. Ideally we would hope to have indicator species to assess habitat quality for biodiversity conservation. Clearly one requirement an indicator species must fulfil is its usefulness in small or medium scale habitats. Presence or absence of long-distance migratory species does not inform us on the quality of a local protected habitat. These species may come in when initially selecting a site for protection but not for monitoring habitat quality once a protection site has been identified.

We agree with Disney (1986) that (1) the choice of species-based criteria for habitat evaluation requires detailed knowledge of the taxonomic group, and (2) the fragmentary state of our knowledge, even in the case of invertebrate faunas, restricts the choice of above-mentioned criteria. We suggest focussing research on 'knots' of the ecological web (Andrewartha & Birch, 1986) and reviving the concept of functional key species for conservation (Kapoor-Vijay & Usher, 1993). For example, burrowing species both vertebrate and invertebrate may function as biodiversity drivers and might serve as excellent indicators to be included in local habitat quality assessment (Meadows & Meadows, 1991).

Research needs for the Biodiversity Action Plan on the Conservation of Natural Resources

Kajetan Perzanowski, Carpathian Wildlife Research Station, Poland

While trying to approach the BAP we should be sure that we are all talking the same language, i.e. it is necessary first to agree how to measure biodiversity in standard, universal terms.

Undoubtedly, measurements of genetic diversity would be an ultimate goal, but at the present knowledge level it simply cannot be applied in the majority of cases. The best recognised at the moment are species and habitat types. Therefore, it seems that a universal indicator of biodiversity, possible to apply in whole of Europe, should be based on species richness and habitat complexity.

While species are fairly well defined, habitat classification still differs among some countries and even among various disciplines (e.g. botanists and foresters). Obviously, for programmes designed for European scale some degree of generalisation will be necessary, and at present probably only one system of habitat classification is sufficiently widely recognised - the Natura 2000 - here I absolutely agree with Katalin Torok, but the indicator should include also a spatial component to reflect mutual interactions among neighbouring habitat types.

Here appears the issue of the scale of mapping i.e. a compromise between the necessity to reflect real situation on the ground and an ability to handle the data at European level. Now coming back to the issue of species - again probably our knowledge on incidence, numbers and dynamics - for a number of invertebrates, fungi, soil micro-organisms etc will be insufficient, so most probably some focal or umbrella species (see contribution from Jaroszewicz and Jedrzejewska) should be selected for this purpose.

We probably all agree at this stage that we are unable to construct a very precise, and elaborate indicator of biodiversity, however for the purpose of selecting the most valuable and threatened sites in Europe, the indicator should be universal enough to allow for a comparison not only among similar habitats types (e.g. deciduous forests in northern Spain and Lithuania), but also to value such different habitats like Hungarian Puhsta and a coastal zone of Holland or northern Germany.

Research needs for the Biodiversity Action Plan on the Conservation of Natural Resources: Summary of session 2 and introduction to session 3

Tiiu Kull, Session chair, Institute of Zoology and Botany, Estonian Agricultural University, Estonia

During the previous week we discussed the research needs in terms of organising biodiversity conservation. Problems with formation of well-defined networks of protected areas and corridors in between them were considered. While moving from species-based approach to habitat-based approach new opportunities and challenges occur, as do needs for additional research taking into account the community and functional links between species and the spatial context of their habitats. The importance of participation of social scientists in biodiversity studies has been stressed frequently, but the links are so far too weak.
During this week we have the opportunity to discuss planning and harvesting.

Efficiency of networks of protected areas - do they really work and contribute for the halt of biodiversity loss? Are they providing enough life-support and environment-support for sustaining economic activities such as agriculture or fisheries?

Are studies of different environments (such as air, water, soil) in balance with their ecological importance? Do we know what the relative importance of these different environments for conservation of natural resources is? Is the conservation and harvesting of natural resources in balance? Is there any sustainable balance between the two? How do we measure that balance?

A spatial approach to determining research needs

Peter Nowicki, Centre for Ecology and Hydrology Banchory & European Centre for Nature Conservation, Tilburg, The Netherlands

SUMMARY: A biodiversity action plan for the conservation of natural resources requires a research agenda that is determined by a spatial analysis of ecological processes and their changes brought about by human land use.

The conservation of natural resources is at the cross roads of several spatially significant sectors of human activity, and agriculture, for example, is the object of another EU Biodiversity Action Plan. Transportation networks and tourism in particular and spatial planning generally also are directly relevant for the conservation of natural resources, so the research needs for the BAP on the conservation of natural resources are a common focus for a wide array of sectors.

It is noted in the Commission Communication under review here (COM (2001) 162 final) "planning approaches … should also play a substantial role in achieving the objectives of the biodiversity strategy." If spatial planning is to have a central role, then the ecological principles that structure the planning process have to be explicit. Although a working group in the 5th Framework Programme project BioForum (www.nbu.ac.uk/bioforum) is examining this matter, the range of experience in Europe is certainly more extensive than a single project can reasonably explore. So certainly an effort to systematise and perhaps unify ecological principles for spatial planning into a common code would be a priority for research; the application of such ecological principles to the elaboration of a number of sector plans (e.g., transportation networks and tourism programmes) would be of evident benefit.

There are two nature conservation directives, relative to Birds (79/409/EEC) and Habitats (92/43/EEC), and together there is a direct spatial application of European responsibility within the Natura 2000 network. The Habitats Directive in its Article 6 establishes a requirement for plans and programmes of a spatial nature to appropriately account for any potential negative impact upon the Natura 2000 network, and on the favourable conservation status of priority habitats and species. Although sound ecological principles, as above, will go a long way to attenuating the possibility of negative impacts arising, there is still a special field of expertise related to working with the implications of Article 6 in spatial terms. Of particular concern is to understand ecological relations spatially, so that the proposal of alternatives and/or compensation measures in plans can be assessed in terms of results throughout an area rather than only at a site directly effected.

Another spatial dimension within the BAP on natural resource conservation concerns river basin management, referring to the Water Framework Directive (2000/60/EEC). A EU policy that focuses on aquatic ecology as applied to entire river basins is in need of considerable support from the research community. Understanding ecological relations spatially is already difficult enough in terms of what happens around a particular site, so the shift in magnitude of area involved in a river basin by itself indicates the added degrees of complexity. Associated with aquatic ecology is the terrestrial land cover within the river basin that has an ecological function directly related to water quality, as well as both the regulation of surface water flow and underground retention capacity. How changes in terrestrial land cover influence aquatic ecology specifically, and the hydrological aspects of river basin management generally, is the last of the spatial issues to be highlighted in this brief introduction to research needs for the BAP on the Conservation of Natural Resources.

Do we need tradable habitats?

Frank Wätzold, UFZ Leipzig-Halle, Germany

Research by Ando et al. (1998) published in SCIENCE has shown that significant cost-savings in the selection of areas as reserves can be achieved without compromising on ecological aims when not only ecological but both ecological (number of species) and economic criteria (land prices) are being considered.

While the analysis by Ando et al. helps to understand how to choose reserves cost-effectively in a static setting, we do not know how to respond cost-effectively to changes in economic criteria over time brought about by economic development. A possible option to take into account such changes and thus the dynamics of economic development is the implementation of the instrument of tradable permits in the area of biodiversity conservation.

The basic idea is to establish a market where habitats can be traded. If for reasons of economic development it becomes worthwhile to develop a certain area with a protected habitat, a developer can do it as long as he provides an equivalent habitat elsewhere. To do so the developer is willing to pay a certain price for an equivalent habitat and thus other land owners have an incentive to establish a habitat and sell it to the developer. As the costs of establishing this habitat will be lower than the costs of not developing the old habitat (otherwise a market transaction would not take place and the developer could not develop the old habitat) we have a cost-effective solution. Tradable permits have been implemented successfully in the field of water and air pollution mostly in the USA. The EU is catching up and soon going to introduce the world largest permit scheme with the Directive on a CO2-Emissions Trading Scheme. However, tradable permits have not yet been implemented in the area of biodiversity.

It would be very interesting and potentially fruitful to explore whether a mechanism such as a tradable habitat system can be found that allows potential cost-savings to be explored when economic costs of reserves change over time. A possible connection to ecology may be the concept of dynamic ecological networks. According to Opdam et al. (2004) ecological networks are a spatially arranged set of ecosystems of the same type which are linked within a spatially coherent system. The key feature of the networks is that they can have different spatial configurations and still serve the same conservation goal. In other words, some parts of the networks can be removed as long as others are supplemented. A tradable habitat system would here serve as an institutional mechanism to co-ordinate such changes in the network.

One can think of many reasons why it is difficult to establish an instrument of tradable habitats. However, concerns were also raised before tradable permits were implemented in the fields of water and air pollution. Research helped to clarify these concerns and to improve our understanding under what circumstances tradable permits are useful policy instruments. The same research process is now needed to understand under what circumstances the instrument of tradable permits can be implemented in the field of biodiversity.

RE: Do we need tradable habitats?

Felix Rauschmayer, UFZ Leipzig-Halle, Germany

As Frank wrote: research on concerns is needed in order to find out whether tradable habitats are a cost-effective way for nature conservation.

Some of these concerns might be:

1. The equivalence of habitats is not easy to define.
2. If the principle of equivalence is not defined too loosely, then there are very few equivalent habitats.
3. Institutional barriers impede the trading of valuable habitats.

Ad 1. a) Talking of equivalence means to take an instrumentalist point of view - equivalence is always for someone or something. Talking of equivalence therefore means to exclude intrinsic values from the consideration.
b) Habitats usually fulfil different functions which cannot be subsumed under one overall function. Questions of importance of different functions have to be answered before or in the process of stating the equivalence or difference of different habitats. There is no theoretical reasoning for one rather than another scheme of importance, e.g. between the criteria of ecosystem stability and biodiversity.

Ad 2. If one maintains several criteria of defining the value of habitats, then it will be impossible to find exactly equivalent habitats. Even roughly equivalent habitats will be difficult to find. Therefore, one will need a value function. Value functions are already used in several countries e.g. in EIA for environmental damages due to large constructions (highways, large construction sites...). These value functions often define the value of a habitat according to observations of its parts and herewith define its equivalence with another, often very different habitat with different ecological functions.

3. If the idea is to trade an ecologically important habitat against another, practical questions come up as well: If the other habitat (not the one which should be given up) is valuable as well, then it will already be part of e.g. the Natura 2000 network. Then the only option is to develop its ecological functions (or the ecological functions of ecologically non-important pieces of land/sea/lakes...). Here, we will have the difficulty of the time span: lose ecological value at once and gain ecological value in 150 (or so) years. And we have the difficulty that it is impossible to ensure the implementation of gaining the ecological value throughout the next 150 years is institutionally a very challenging endeavour (what happened to pieces of land in the last 150 years?).

So, my conclusion: nature conservation is not as easy as retaining CO2, but it is a multi-dimensional, spatially dependent task with a far-reaching time horizon.

But I agree with Frank that one needs research on these issues (even when not considering tradable permits as a good idea). Taking up my three points, I come to the following three research topics:

1. Which processes are appropriate (i.e. use local and scientific information, are legitimate, change the institutional setting in favour of nature conservation, are rather cost-effective) in order to evaluate habitats?

2. How could one overcome the gap between theoretical impossibility of defining overall equivalence and the practical need to do so (at least sometimes)?

3. Which are the institutional barriers to the conservation of ecologically important and the development of not yet important habitats? How to overcome these barriers?

Research needs for restoring biodiversity in Europe

Rudy Van Diggelen, University of Groningen, The Netherlands

SUMMARY: Research should focus on selecting, designing and testing restoration and management techniques that help to rehabilitate disturbed ecosystems or to restore damaged ones. Such knowledge is essential for the conservation and increase of biodiversity but the present know how is not sufficient to reach this goal. The following research areas are suggested to focus on in the coming years to support restoration success for European scale environmental issues: (i) restoration of active floodplains; (ii) renaturalisation of former arable land; (iii) restoration of peat lands.

1. Restoration of active floodplains along European rivers: Most European rivers are now straightened and embanked. This has not only led to a significant decrease in biodiversity but also to increased flooding risks. Consequently, re-installing former flood plains would counteract these negative effects. Moreover, nutrient removal from the polluted streams could increase their role as drinking water supplier and release the pressure on groundwater for drinking water purposes from other areas. Research should provide guidelines on the size of the area, investigate the effectiveness of nutrient removal and estimate size and rate of biodiversity change.

2. Renaturalisation of former arable land on infertile soils: The agricultural area in Europe will diminish in the future, especially on infertile soils. Until recently such areas were kept productive by a massive input of fertilizer but this is no longer economic. They are abandoned on a large scale, especially in the new member states but this does not lead to a significant increase in biodiversity. In the past most sites used to be species-rich but it is unknown whether the former situation can be regained. The mechanisms are only partly clear and include biotic processes such as propagule survival and dispersal and abiotic ones, especially nutrient processes in the soil. Research should focus on the constraints of restoring these communities and provide guidelines to overcome the problems.

3. Restoration of large-scale peat lands: Global warming due to increased CO2 levels in the atmosphere is seen as one of the major threats to biodiversity. Sinks for greenhouse gases are seen as priority measures but most sinks release CO2 again. Peat lands are an exception to this rule. Apart from that, several mire types are considered as priority habitat in the Habitat Directive, especially some fen systems. Restoring such ecosystems on a large scale would suit both goals. However, knowledge on this subject is limited and involves both ecological and hydrological disciplines. Research should focus on the possibilities to restore peat-producing ecosystems in a sustainable way.

Research needs relating to medicinal plants

Lars Bjork, Ethnobotany department, Uppsala University, Sweden

I would like to draw attention to the situation in the former communist states in the Balkans.

The area exports large amounts of medicinal plants, (25-40.000 tons of dried plants per year) which are also the basis for the village "pharmacies". Most of the materials are wild collected plants and several species are now threatened through over-collection. Most of the collectors are elderly women with poor economy. Shortage of plants results in a more tedious collection, new areas for collection and possible conflicts between collectors from different ethnic groups trying to get the last individuals from the same area.

Solutions:

- Research that defines threatened species in the area.
- Selection of genotypes with high accumulation of active compounds
- Propagation of selected genotypes
- Domestication of propagated material
- Training in horticultural production of selected species by former collectors.
- Organizing co-operative post harvest treatment

Research work should be performed in cooperation with individuals from the different ethnic groups. A small program has already started by the Bulgarian Academy of Science, professor Estatieva.

Efficiency of protected areas and missing link to strategies outside

Rainer Muessner and Isabel Sousa Pinto, Centre for Marine and Environmental Research (CIMAR), Porto, Portugal

SUMMARY: The authors call for research to improve the efficiency as well effectiveness of protected areas. Furthermore research has to be done on the various interactions between protected and non-protected areas to engage segregative and integrative strategies.

In her opening statement Tiiu Kull asked for the efficiency of protected areas, if they work and contribute to the halt of biodiversity loss. At least the last part of the question can be answered positively. I guess there is no doubt that different protected areas around the globe contribute to the halt of biodiversity loss. Lots of natural resources would have vanished from our world, if we hadn't established the network of protected areas. Some success stories of nature conservation in the last century, documented for example in the Blue Lists (Gigon 1999, Gigon & Langauer 1998) are based on protected areas and their management. But most probably, even if we could double the areas of protected area on the globe, the strategy of protected areas alone would not halt the loss of biodiversity if there is no consistent strategy outside the borders of the areas. Both strategies have to engage if we want to reach the ambitious aim of halting biodiversity loss by 2010. But if we read the BAP on natural resources carefully, we see that it is not all focused only on protected areas, which is quite important, because at least in Western Europe protected areas are likely to level off on the current stage (EEA 2003a, IUCN 2003a+b) and after all, protected areas have some system immanent weakness (to small, no connectivity to other reserves, to static to cope with climate change) that are hard to overcome.

There is an urgent need to clarify the effects and interactions of protected areas with the non-protected areas around them. There are a variety of different ecological and economical interactions. For example protected areas have a "source-function" for some populations, but this is rather irrelevant if the surrounding areas don't have ecological minimum qualities to allow the establishment of the emigrating organisms (sink-function). Furthermore the establishment of a protected area leads in many cases to a change in land prices in the areas outside these areas. This makes the planning tasks outside the parks more difficult, due to changed property rights or special configurations of land-use (see also contribution from P. Nowicki). The protection of natural resources in protected areas can also lead to a higher pressure to use them outside the park. This has been shown in some cases for the marine protected areas that shifted fisheries to previously undisturbed or little disturbed sites. That means the positive effects are reduced by negative effects outside the protected areas.

So it's not always clear if all the protected areas really protect biodiversity and its natural resources effectively, and evaluation of the efficiency of this protection (and why it is working or not working) would help to better design and manage these important instruments of biodiversity protection. For this assessment the objectives for the protected area should be defined explicitly as well as the targets of the management scheme. Success in fulfilling the objectives can then be evaluated. Therefore we see a need to do research to develop scientifically sound methodologies to evaluate the effectiveness of protected areas and their management plans.

Most difficult to answer is probably the first part of Tiiu's question – how efficient are the protected areas. If we calculate the resources invested (money, working hours, activities) against the out-put (species protected, habitats etc) we'll end up sometimes with an impression of low efficiency. But if we try to ask questions like: Was there a better alternative than establishing a protected area? Were the alternatives more likely to fulfill the objectives or how would the natural resources look like if no protective measures had been taken, we'll end up with a more positive view. The central research question to improve this efficiency

may be: how to enhance the selection /planning of areas (Poiani et al. 1998) and management procedures (i.e. Integrated Adapted Management (IAM)).

Research for BAP natural resources:

• Research on the various interaction between protected and non-protected areas and how to engage both strategies

• Research to develop sound methodologies to evaluate the effectiveness of protected areas and their management plans.

• Research on how to enhance the selection of sites and the management procedures to raise the efficiency of protecting natural resources (inside and outside protected areas).

RE: Efficiency of protected areas and missing link to strategies outside

Klaus Henle , UFZ Leipzig-Halle, Germany

Rainer Muessner & Isabel Sousa Pinto pointed out two of the core research questions that I fully support: a) How to improve the efficiency of selecting/planning areas, and b) How to improve the management of the areas.

I would like to add that research for a) must cover both an efficient local/regional planning of the area to optimise its ecological efficiency given local constraints but also complementarity planning on the national and the European level. So far complementarity issues are insufficiently taken into consideration making systems of protected areas much less efficient than they could be with a more systematic planning. On a European scale this means we also have to develop a methodology that allows the identification of national responsibilities and priorities for the conservation of species and habitats that is not simply based on Red Lists but takes into consideration relative contributions that a country could exert on the threat/protection of a habitat/species (maybe, the EU subsidiarity principle could be used to get support for such a strategy).

Regarding b) we need to consider both, the management of the reserve itself but also the interaction of the reserve locally or regionally. Especially, the planning and management of protected areas need to carefully consider which societal and ecological effects it has on the surroundings and how it will create, strengthen, or mitigate, solve conflicts.

Research that allows a better integration of these aspects is needed.

RE: Efficiency of protected areas and missing link to strategies outside

Kajetan Perzanowski, Carpathian Wildlife Research Station, Poland

Referring to contributions by Klaus Henle, Rainer Muessner and Isabel Sousa Pinto - the truth is, that protected areas cannot be the only mechanism conserving the biodiversity, however this is at the moment the only tool to protect and maintain the most sensitive (valuable?) biological systems we can identify within the continent. The important thing is that such areas usually have quite a good inventory of local flora and fauna, so an estimate of a biodiversity index for such sites should be easier than anywhere else. The problem is how to avoid the transformation of those areas into isolated islands surrounded by completely altered environment. In contemporary Europe, any significant extension or creation of new sizeable strictly protected areas, does not seem to be the realistic approach. Instead, we should tend to establish buffer zones wherever it is possible and tend to maintain or create a linkage between presently protected areas. Here, perhaps a next step in the development of Natura 2000 system can be a solution. The other issue is to standardise protective regimes for well defined categories of protected areas so we could be sure what level of protection is possible to achieve at given site. At the moment, even the status of "national park" does not mean the same in Poland, Great Britain or Slovakia.

RE: Efficiency of protected areas and missing link to strategies outside

Richard Ferris, JNCC, UK

Kajetan Perzanowski's contribution raises a number of important points that I would broadly support. Protected areas alone are not the only means of conserving biodiversity, but I think we need to be careful about generalisations that only in these designated areas can we protect the most sensitive species and communities. Sometimes, quite incidentally, managed habitats (even of non-native species, in the case of some forested areas) can offer refugia for species in decline in protected areas! Managed landscapes can and do support biodiversity, and the big challenge for researchers is to consider how best to integrate biodiversity conservation in managed and strictly protected areas. In reality, of course, these are not the only options, existing as they do on a sliding scale from extreme intervention through to minimal or non-intervention. Yes, buffering of protected areas may well be necessary to ensure that an adequate area is maintained in suitable condition to support minimum viable populations for certain species. However, where natural processes may no longer operate (or do so only in a modified manner), management may well be required. So, in short, we need a dual, indeed multiple approach to biodiversity conservation. In the UK, where we have landscapes that have been shaped by human intervention, our native biodiversity is reliant on management. This makes it very difficult to see how we could have a single European definition for National Parks, covering truly natural and semi-natural habitats. That said, however, I fully support the suggestion of an extended Natura 2000 approach, building up a sustainable network of protected AND managed areas. The key research task may well be to continue to develop our understanding of how managed interventions can mimic natural disturbance processes and patterns, and how these contribute to the conservation of biodiversity.

RE: Efficiency of protected areas and missing link to strategies outside

Per Sjögren-Gulve, Department of Conservation Biology and Genetics, Uppsala University, Sweden

"No park is an island" (Beginning of an article by Daniel H. Janzen in Conservation Biology in the late 1980s).

I fully support the view(s) presented in this discussion. Even though a valuable nature area is protected, its surroundings may act like a "population sink" where emigrants do not survive, thus decreasing the growth rate of the source population and thereby increasing its extinction risk. We showed this in a correlative way for Swedish pool frogs (Sjögren-Gulve & Ray 1996). Another aspect is edge effects that can be beneficial for some species but severely negative for others. The "population sink effect" very much depends on the scale and on the dispersal abilities and behaviours of the species. In this context, research on the dispersal ability of indicative species or species groups would provide valuable information.

In Sweden, we are presently initiating a multidisciplinary synthesis where the effects of the forest stewardships (i.e. FSC and PEFC) on biodiversity conservation in the forest landscape are reviewed. While species and habitats threatened by forestry must have protected areas designated for them, the purpose of the certified forestry seen from a nature-conservation perspective would be to provide good-enough surroundings for species survival and habitat maintenance at both local and landscape levels. This view can be generalized to other landscape scenarios, and is an important issue for research and review.

To Klaus Henle's points I would like to add that there is also a genetic and geographic diversity aspect of the protection of species and habitats in more than one country or province. It also reduces the risk and negative effect of local catastrophes on species and habitat conservation. All nations that have ratified the CBD have agreed to conserve their biological diversity. So while an international perspective might help prioritising some highly

valuable populations in a country, we must not let this become an excuse to entirely hand over the conservation responsibility of indigenous species abroad.

RE: Efficiency of protected areas and missing link to strategies outside

Javier Cabello and Domingo Alcaraz, University of Almeria, Almeria, Spain

Rainer Muessner and Isabel Sousa Pinto call for the efficiency as well effectiveness of protected areas. Beyond standardising protective regimes, to avoid population-sink effect or create buffer zones around reserves, we still encounter the dramatic reality they pointed out: "Even if we could double the areas of protected areas on the globe, the problem is how avoid the transformation of those areas into isolated islands surrounded by completely altered environment".

In SE semi-arid Spain where intensive agriculture and residential tourism are very important economic sectors (as probably all Mediterranean coast of Spain), current land-transformation rates lead to full isolation of protected areas and to confine the nature in those areas in a few decades. From this point of view, in addition to research on restoration and management population or habitats, connectivity, conservation biologists must deal with the integration of local and regional biodiversity objectives in sectoral policies and the public opinion.

On the other hand, in order to answer the question of how efficient the protected areas are, we must emphasize conservation objectives based on ecosystem approach. For example, the admission of conservation values in landscapes like Mediterranean coasts, often lead to the creation of a very small reserves (micro-reserves) with one population as conservation objective (and in a few cases habitats too). This single-species approach has leaded to translocations of populations in the face of high pressure on the land and do not prevent the full transformation of the landscape.

RE: Efficiency of protected areas and missing link to strategies outside

Jiri Pokorny, Agency for nature Conservation and Landscape Protection of the Czech Republic

Referring to the interesting discussion to the efficiency of protected areas - it is clear that a system of protected areas has its significance and importance but also systematic weaknesses as it was mentioned. It is also clear that (at least in the political circumstances in new EU member States) it is impossible to considerably enlarge the number and area of strictly protected areas, reserves etc, where the protection regime means a lot of restrictions, regulations etc. Strictly protected areas that are only devised to maintain the biodiversity (and to protect it "against people") have their role, but the role is limited and in some species and habitats the network could cover only a minor part of the resource. Therefore it seems realistic and modern to take the approach of creating a system of network areas that is based more on sustainable use rather than on strict protection.

The Habitats Directive in Natura 2000 brings up such a modern approach. The Natura 2000 approach can also be described as "nature for people" and not only for nature itself and against the people, which is often the way the public and politicians regard it. The important aspect is that in such an approach the economic, social and regional aspect of activities are taken in account. To integrate the needs of people living on the site with nature conservation goals seems to be the only realistic approach that can be applied on larger areas.

In the Czech Republic we propose larger Natura 2000 sites, which should be well-maintained and definitely not to be islands in the landscape. Often the Natura 2000 sites are proposed as larger areas containing the already small-scale protected areas (reserves). E.g. larger forest sites include a small nature reserve with a well-developed structure of forest stands and it is surrounded by larger areas with common forest management. However, the

current harvesting on the site is not in collision with the need to maintain it. Thus, Natura 2000 can be a stepping stone between strictly protected areas and managed (harvested) areas. Of course the protected areas where the nature conservation will have more ambitious conservation goals remain but it is not unlikely to enlarge them. It is important that, in systems like Natura 2000, a high portion of the total resource (e.g. forests) in many habitats can be covered by the network. These habitats are usually the subject of economic use. It seems it is possible to protect such habitats widely occurring in the country only in co-operation with the landowners and farmers, people living in the countryside. Our main task should be to find out integrated compromise management fulfilling the needs to maintain the species and habitats as well as the needs of harvesting. Natura 2000 network gives an opportunity to do so. A big challenge can be also for schemes supporting environmentally friendly silviculture and agriculture (e.g. agri-environmental schemes) to be more specifically designed to the direct management of the habitats. When such cooperation and integrated management will be established it will in future be easier to extend it outside protected (Natura 2000) areas. That would be a dream for nature conservation in the future not to be done by nature conservation bodies but in close cooperation and often directly by the local people farming in the countryside.

RE: Efficiency of protected areas and missing link to strategies outside

Alessandro Gimona, Macaulay Institute, UK

Climate change will be an important factor influencing future land use change. Land use change, in turn, will influence the distribution of habitat and species in a warmer world. More research is needed to develop an understanding of future land use and landscape change and effects on nature conservation networks.

I fully support the view that we need more research on the effect of climate change, both on networked and non-networked protected areas. Given the future projections regarding change, and the preliminary results of bioclimatic models, it is reasonable to suggest that it would be very surprising indeed if the present number of protected areas and any forming networks were adequate across Europe in 50-100 years.

Evidence of considerable climate change is mounting .For instance, as many know, very recently professor King, the chief UK government scientist, has warned 'decision makers' that levels of carbon dioxide in the atmosphere are already 50 per cent higher than at any time in the past 420,000 years and that the last time they were at 379 parts per million was 60 million years ago during a rapid period of global warming. If increases comparable to those observed in this past warming event were to follow, a massive reduction in life could result. Given this background, it is very important to recognise the problem of impermanence of at least a portion of the present system of protected areas and related networks and to plan for habitats, species shifts, and “network” shifts. Research in this area would be of great importance.

Climate-envelope models provide some approximate answers, but shifts will be mediated through land use/landscape change and therefore these will be very important factors influencing the fate and spatial arrangement of suitable habitats and migration corridors. Although in the geological past habitats have to some extent followed climate, this is likely to happen to a much lesser extent in densely populated continents such as Europe. In other words, because land use/cover is mediated by human decisions (certainly in Europe), it would be very optimistic of conservation officers to assume that habitats will be in semi-instantaneous equilibrium with climate, (although shifts will certainly be influenced by climate). For this reason, climate envelope models, on their own, are unlikely to make reliable predictions regarding future species distributions. Understanding how human decision-making will interact with a globally altered climate and its political as well as environmental effects, is crucial to be able to predict land use and landscape change, and ultimately the fate of protected areas, networks, and related species.

Six years to go: an expanded role for conservation scientists is needed

Per Sjögren-Gulve, Department of Conservation Biology and Genetics, Uppsala University, Sweden

SUMMARY: To halt the loss of biodiversity before the end of 2010 is a formidable task. Important research needs to be initiated, but I argue that there is also an urgent need for more communication and cooperation between researchers and managers that can be achieved only if the reviewing and advisory roles of scientists are expanded in the working process.

To halt the loss of biodiversity before the end of year 2010 is a formidable task. With six years to go, it's unlikely that research initiated today and carried out and published the conventional way will do the job even if the results are sent to agencies and other managers before they are in press. Important research needs to be initiated, but increased communication and cooperation between researchers and managers is even more urgently needed and can be achieved if the reviewing, advisory and cooperative roles of scientists and conservation biologists (including competences in the social and economic sciences) are expanded promptly in the working process. This will cost, but I argue that it is well-spent money and that the positive effects of this investment reach far beyond the sole reduction of biodiversity loss. It opens up for an increased constructive dialogue at both central and local levels. It allows for swifter use of up-to-date knowledge, better and more objective evaluation of measures taken, and for more tests of alternative approaches that allow for increased participation among parties concerned. A major issue at hand is of course to what extent the present-day CAP and the nature conservation directives 79/409/EEC (Birds) and 92/43/EEC (Habitats) will help halting biodiversity loss before the end of year 2010. We see an increasing number of very positive cases in Sweden where conservation biologists (scientists as well as amateur specialists) engage in practical conservation work in dialogue with farmers, other managers, and NGOs, and strengthen the scientific approach as well as the practical one. Increased funding of both intra- and interdisciplinary biodiversity research has contributed to this - for example, programmes such as The Conservation Chain (http://www-naturvardskedjan.slu.se), MARBIPP (http://www.marbipp.tmbl.gu.se), Management of Seminatural Grasslands (http://www.cbm.slu.se/forskning/grassland/grasslands.htm) and projects funded by research councils such as FORMAS (http://www.formas.se). But still significantly more input from scientists is needed if the loss of biodiversity is to be halted by year 2010. What's happening at the EU level and in other EU countries? At present, biodiversity research seems to be under-prioritised in the EU 7th framework research programme. If so, it is an ominous and truly worrying sign in discordance with the statements of the EU and Johannesburg Summit meetings.

The scientific and communicative networks for conservation work are not the only ones we need to carefully consider and sustain – we also need to sustain the human network doing positive management in areas with high nature values throughout the enlarged EU. As is highlighted elsewhere and also in this e-conference, farmers and the traditional farming practice in such areas are of prime concern (e.g. http://reports.eea.eu.int/report_2004_1).

Development of vegetation in extreme conditions

Andraž Èarni, Petra Košir, Aleksander Marinšek, Urban Šilc & Igor Zelnik, Institute of Biology, Scientific Research Centre of the Slovenian Academy of Sciences and Arts, Ljubljana, Slovenia

SUMMARY: The research focuses on the process of development of vegetation in extreme habitats. The process of succession will be studied on the permanent plots that enable the monitoring of the changes in vegetation cover during a longer period of time. The main drivers and pressures on the vegetation will be estimated and vegetation response to the environmental pressure will be studied.

The study will take place on the habitats, where extreme condition are the result of human activities. We will study the development of vegetation on roadside slopes and on the grassland that was severely damaged by mulching. The permanent plots will be established and development of vegetation (succession) will be monitored. The species composition, syntaxonomical composition, number of species, life history traits of plants, etc will be studied and correlated with the regional climate and other environmental factors.

1. Restoration of roadside slopes

The roadside slopes are one of the habitats that became quite common in the landscape. They are mainly restored by lowering the inclination and sowing. Less often they are left to spontaneous succession, since erosion would soon damage the slopes. Nearly always slopes are sown, and various sowing mixtures, with or without nursing grass are used. We will find out which sowing mixture enables smoother succession course. At the same time appearance of indigenous plant species will be studied that arrive partly from the seed bank as well as from the neighbouring vegetation. These species are desired, since they build the succession line towards the potential natural vegetation.

2. Restoration of grassland after mulching treatment

The grassland is mulched. This treatment grinds grassland tussocks as well as soil layers. Since the vegetation cover is destroyed, the erosion begins and various sites conditions appear: there are sites composed of bare rocks, only with a small amount of soil partitions and also the sites where the accumulation of soil enables even the establishment of nitrophyllous vegetation. This research will enables us to study of succession of line on various sites condition in the rather limited geographical distribution.

Past spatial and management patterns

Tomas Cerny, Charles University, Prague, Czech Republic

SUMMARY: When discussing effectiveness and possibilities of biodiversity protection in special protected areas, or when extending the concept of sustainable use of resources throughout the whole landscape, without the loss of biodiversity, we need to take into consideration the spatial and management pattern of habitats in the past.

Our predecessors lived and worked in a way that led to a variety of habitats with very broad diversity of environmental conditions, supporting motley assemblages of plant and animal communities. The overall feature of their activity was permanent disturbance of low intensity everywhere and small-scaled spatial stochasticity of management and pattern of plots with the respective treatment (biologically alien chemicals excluded, naturally). Even though these people were not "ecologically-skilled", the carrying capacity of the landscape was apparently high. Furthermore, we should consider the co-evolution of species' genetic diversity and their gene pool with past human interventions. This is cross-linked and there is intensive research on the extent of this linking, i.e. where are the limits to successful reproduction of biotas in the landscape structures, if we decrease the general area of the respective traditionally managed semi-natural habitats (meadows, wetlands etc.), fragment them or put them in a vulnerable and unstable situation. I am not sure about the plausibility of special management, no matter how ingenious or in-depth, as one widely expects aspect of halting the biodiversity loss, if the three above-stated hindrances exist.

One example of the problem: For successful rehabilitation and conservation of wet meadows in alluvial basins it is essential to recover the natural hydrological conditions (i.e. the meandering of stream, flooding, permanent erosive and accumulative processes, fertilisation of stands by inundated warp). But this is in striking contrast with demands of accessibility and exploitation of naturally fertile lowlands to society: crop production, protection of riverbanks, and various constructions etc. from erosive activity of water. The idea of crop production here, for example, is deeply nested in human minds, having consequences in noisy aversion for extensification and land conversion in alluvial basins. The status of wealthy lowland close to rivers will be very similar to patterns e.g. 150 years ago (in the central Europe), where we can see predominance of grasslands, wetlands and grazed plots, broadly interconnected, with scattered small-sized crop fields, this all in the framework of curly-like riverbed.

Universally recommended afforestation can be another example of sources of failure in biodiversity protection. Common demands on the status of forests (bulky trees with high crown, mild microclimate, absence of disturbances) has a positive effect on the development of the woody component or carbon dioxide economy on the one hand, but can critically endanger reproduction of some desirable organisms through mesophylisation on the other hand (e. g. light-demanding herbs and butterflies, encouraged by browsing of breeding animals and coppicing). Also, afforestation of seemingly erosion-prone habitats or "non-fertile, bleak" plots (steep slopes, stony balks, brook floodplains etc.) has generally the fatal effects on variety of specialised plants and animals. To sum up, the first stepping point in prioritising our collection of information about ecosystems and in searching for the best management practice is the past experience, without which we could not understand the present status and distribution of biodiversity and we will find it considerably difficult to reach a reversal in the biodiversity decrease.

The Natura 2000 network and global climatic change

Flemming Skov, National Environmental Research Institute, Department of Wildlife Ecology and Biodiversity, Denmark

Major climatic changes are predicted for the coming century as a result of increasing atmospheric concentrations of greenhouse gases. Most scientists expect increased temperatures in the range of 2-5ºC, but some climatologists and oceanographers are worried that a warmer climate may have unexpected consequences for deep-water formation in the North Atlantic. This may change the course of the Gulf Stream and result in a colder climate. In either case, the future climate may be very different from what we experience today.

The design of networks for preserving biodiversity is mainly concerned with present day distribution of habitats, plants and animals. Various measures of biodiversity are used to select areas including species richness, rarity, hotspots of endemisms and various algorithms for designing the optimal network of reserves have been developed. Historical biogeography provides us with rather detailed information of past biotic responses to climate change, but this knowledge is rarely used in reserve design. This is also the case for the Natura 2000 network.

Given the difficulties in determining whether or not the Natura 2000 network is adequate for the protection of present patterns of biodiversity, it may seem presumptuous to suggest that we also try to incorporate mitigation of climatic change into the network. On the other hand, global climatic change is expected to occur very rapidly (within this century) and we need at least an assessment of how sensitive the Natura 2000 network is to warmer as well as cooler climates. Research needs are obviously immense, but a preliminary research agenda could include:

1. Modelling future potential distribution of a number of species under various climatic change scenarios. Modelling techniques (bioclimatic envelope models) are well developed and may be employed to estimate losses or gains of suitable potential distribution area.

2. Analysing opportunity for dispersal. Predicted climatic change may result in range shifts of more than 500 km. within a century. The success of tracking such range shifts depends on a species' ability to exist and pass through the matrix of land uses surrounding protected areas. The management of these areas, consequently, becomes even more important for the protection of biodiversity than it is today.

3. Developing an approach to supplement the Natura 2000 network for optimal performance under various climatic change scenarios. This could include recommendations for managing the matrix to maintain various types of natural or semi-natural vegetation and populations of potential long-distance dispersal agents such as birds and mammals.

Climate change, habitats and conservation philosophy

Johan Rova, Jönköping County Administrative Board, Sweden

The impacts of climate change on Natura 2000 habitats definitely need to be discussed. But also other long-term impacts on habitats and biodiversity, such as acid rain and nitrogen deposition.

In Sweden, we see that the open areas of raised bogs decrease, as birch (Betula) and pine (Pinus) invade previously unforested parts of open bog. This could well be caused by nitrogen deposition and warmer climate. What should we do with these habitats in the future? Clear-cut the invading trees from these areas to keep them open according to the status of the Natura 2000 network?

Looking back in history, we can see that the climate has changed over the last 10.000 years since the last ice age. At a couple of times during this period, climate has been warmer, water levels lower, and peat accumulation on the raised bogs has then decreased and pine has

invaded bog areas. When climate later changed to become colder and wetter, peat accumulation started all over again, and the invading pine was killed by rising water levels. To some extent, the present day forestation is thus just repeating what has happened in previous times. But where is the border between natural and man made climatic impact on the raised bogs? Should we in the future manage the raised bogs by cutting down pine and birch, or "just" by working against an increased global warming?

Is the EU legislation prepared to meet the impact of global warming on management of Natura 2000 habitats? I think the question should be stretched to a philosophical point: how should we manage the areas when new climatic conditions make it impossible to keep the habitats as they are today? Climatic conditions will also change naturally, even before we reach the next ice age in a couple of thousand years.

RE: Climate change, habitats and conservation philosophy

Kajetan Perzanowski, Carpathian Wildlife Research Station, Poland

The contribution from Johan Rova raises another important issue - what should the real aim for protected areas (and protection of biodiversity) be? Either we try to maintain present (or historic) status quo - fighting against changes caused by global warming, new ice age etc. or we protect natural processes of adaptation to changing conditions. In other words should we accept and protect evolutionary processes, including unavoidable loss of certain components of biosphere, or should we struggle to petrify our present reality?

Summary of the Research needs identified for the Biodiversity Action Plan Conservation of Natural Resources

Tiiu Kull, Session chair, Institute of Zoology and Botany, Estonian Agricultural University, Estonia

What to preserve?

- Inventorying of our biodiversity and preparation of catalogues of living organisms for each region or biota requires a lot of taxonomic work.
- Research is also needed into the distribution of morphological characters in Europe's plant species – linking this to knowledge about the genetic diversity in European plants will allow us to assess plant phylogenetic richness in Europe and to prioritise the selection of plant species based on phylogenetic uniqueness
- For conservation of genetic diversity it is important to carry out key studies on the genetic variation and specificity of local populations of endangered or rare organisms, or organisms of significance for habitat rehabilitation
- Distribution data and knowledge about abundances of many species are fragmentary
- Diversity of functional groups should be studied and maintained
- Tools and methods to save our natural resources facing global warming are needed.
- We also need to quantify threat – how else can we define a threatened species? Assessing threats will require research into the links between distribution, both at the population and species level, and human alteration of the habitat – including climate change.
- Research for conservation must be conducted in a framework that ensures fit for purpose.

How to preserve?

- To develop modelling tools for the sites that integrate the ecological aspects especially with regard to the site's conservation objectives
- To develop methods to increase the capacity of ecological corridors, use indicators to assess this capacity.
- Afforestation by native species in the floodplains will decrease flood risk in European catchments, how should we organize this?
- Techniques to handle the populations of invasive species have to be developed for the most noxious plants.
- The efficiency of individual Species Action Plans (SAPs) may be questionable, but do we know enough about techniques for managing different habitats to optimise species conservation, when autecological needs may be very specific? Should research be directed into conservation strategies that address communities rather than species, these communities being defined by the broad habitats in which they occur? (E.g. a BAP for bird communities of broad-leaved deciduous woodland). Such an approach could be further refined to take into account particular feeding or functional niches. Research could usefully be geared towards understanding the generic habitat requirements of these community types.
- If we move away from a species-by-species approach, can we ensure that habitats are maintained within sufficiently robust limits to minimise risks to species and communities? Will we need to realign the criteria by which we assess habitat condition? What role might be played in species survival by sub-optimal or alternative habitats/refugia?
- In order to enhance the ecological function of landscapes, e.g. through the establishment of sustainable habitat networks (e.g. Natura 2000), research is needed to convert theory into practice. An urgent need for more communication and cooperation between researchers and managers exists.
- There is a lack of detailed studies on the effects of nature conservation areas. Better integration of social sciences such as Sociology, Anthropology and (Social) Psychology in interdisciplinary research projects on natural resources management is needed.
- Measuring habitat quality is a complex process. A focus on developing functional key species, which may serve as biodiversity drivers for local/regional scale monitoring, is needed.

- Research should focus on selecting, designing and testing restoration and management techniques that help to rehabilitate disturbed ecosystems or to restore damaged ones, e.g. (i) restoration of active floodplains; (ii) renaturalisation of former arable land; (iii) restoration of peat lands
- Needs for viability and risk analyses lasts and further research in this area should be enhanced.

Planning, harvesting

- An effort to systematize and unify ecological principles for spatial planning into a common code would be a priority for research; the application of such ecological principles to the elaboration of a number of sector plans (e.g., transportation networks and tourism programmes) would be of evident benefit.
- Whether a mechanism such as a tradable habitat system can be found that allows potential cost-savings to be explored when economic costs of reserves change over time. Research process is now needed to understand under what circumstances the instrument of tradable permits can be implemented in the field of biodiversity.
- Research is needed that defines threatened medicinal species in the area, selects genotypes with high accumulation of active compounds, and works out propagation methods of selected genotypes as well as domestication of propagated material.
- Research has to be done on the various interactions between protected and non-protected areas to engage segregative and integrative strategies. In this context, research on the dispersal ability of indicative species or species groups would provide valuable information.
- The first stepping point in prioritising our collection of information about ecosystems and in searching for the best management practice is the past experience, without which we could not understand the present status and distribution of biodiversity and we will find it considerably difficult to reach a reversal in the biodiversity decrease.

RE: Summary of the Research needs identified for the Biodiversity Action Plan Conservation of Natural Resources

Sandra Bell, Department of Anthropology, University of Durham, UK

Tiiu Kull writes: "There is a lack of detailed studies on the effects of nature conservation areas. Better integration of social sciences such as Sociology, Anthropology and (Social) Psychology in interdisciplinary research projects on natural resources management is needed."

This leads to another area for research and, equally important, training. Inter-disciplinary research, which is research that truly integrates different disciplines, is extremely difficult to achieve. There are few examples of it being successful. Where scientists and social scientists work together it often turns out to be multi-disciplinary - with each "side" maintaining their boundaries and carrying out work in parallel with attempts to integrate results at the end of the process. This is not enough. People from different disciplines need to work together, mutually adjusting questions and methods in order to create greater synthesis.

The problems that work against this desirable state are cultural and historical. The intellectual training and foundation of disciplines and sub-disciplines is actually designed to keep us apart. Journals are reluctant to publish articles that are not specific to the discipline that they represent. Even the ways in which we present our findings varies across disciplines and do not translate well. There is need for a complete rethink from the pedagogical perspective through to experimental research projects where the emphasis is placed on learning how to work in an interdisciplinary manner (process) as much as on obtaining results (outcomes). The road to true interdisciplinarity is long. It transgresses European intellectual traditions, the structure of universities and research institutes and other longstanding academic practices. Funding needs to be set aside to face this challenge if we are to achieve many of the goals mentioned by contributors to this e-conference.

RE: Summary of the Research needs identified for the Biodiversity Action Plan Conservation of Natural Resources

Rainer Muessner, Centre for Marine and Environmental Research (CIMAR), Porto, Portugal

In reply to Tiiu's cumulative list of research topics I like to suggest the following small changes (explanations in brackets) in the respective bullet points:

Although all of these points are important from the scientific point of view, I guess for the final recommendations we should tailor it more to the concrete BAP NR and edit it more in form of "Research for BAP NR" (can be done during the conference), other wise it looks more like a "Christmas wish list" from science.

How to preserve?

- To develop modelling tools for the sites that integrate the ecological aspects especially with regard to the site's conservation objectives
- To develop methods to increase the capacity of ecological corridors, use indicators to assess this capacity.
- Afforestation by native species in the floodplains will decrease flood risk in European catchments, how should we organize this? (I would cut this sentence because it is a case study from one ecosystem type (floodplains), that is covered under the category "selecting designing and testing restoration and management techniques" of the last but one bullet point under the group how to preserve)
- Techniques to handle the populations of invasive species have to be developed for the most noxious plants.
- The efficiency of individual Species Action Plans (SAPs) may be questionable, but do we know enough about techniques for managing different habitats to optimise species conservation, when autecological needs may be very specific? Should research be directed into conservation strategies that address communities rather than species, these communities being defined by the broad habitats in which they occur? (E.g. a BAP for bird communities of broad-leaved deciduous woodland). Such an approach could be further refined to take into account particular feeding or functional niches. Research could usefully be geared towards understanding the generic habitat requirements of these community types.
- If we move away from a species-by-species approach, can we ensure that habitats are maintained within sufficiently robust limits to minimise risks to species and communities? Will we need to realign the criteria by which we assess habitat condition? What role might be played in species survival by sub-optimal or alternative habitats/refugia?
- In order to enhance the ecological function of landscapes, e.g. through the establishment of sustainable habitat networks (e.g. Natura 2000), research is needed to convert theory into practice. An urgent need for more communication and cooperation between researchers and managers exists.
- There is a lack of detailed studies on the effects of nature conservation areas, inside and outside its borders. Better integration of social sciences such as Sociology, Anthropology and (Social) Psychology in interdisciplinary research projects on natural resources management is needed.
- Measuring habitat quality is a complex process. A focus on developing functional key species, structures and processes (it's not only species and habitats that play roles for conservation, structures and especially underlying processes have to be covered as well) which may serve as biodiversity drivers for local/regional scale monitoring, is needed.
- Research should focus on selecting, designing and testing restoration and management techniques that help to rehabilitate disturbed ecosystems or to restore damaged ones, e.g. (i) restoration of active floodplains; (ii) renaturalisation of former arable land; (iii) restoration of peat lands
- Needs for viability and risk analyses last and further research in this area should be enhanced.

- Developing mechanisms to set baseline standards for exploitation and the sustainable use of natural resources, based on current knowledge about regeneration and resilience of specific natural resources (maybe listed under "harvesting?").

Planning, harvesting

- An effort to systematize and unify ecological principles for spatial planning into a common code would be a priority for research; How to apply such ecological principles to the elaboration of a number of sector plans (e.g., transportation networks and tourism programmes) would be of evident benefit. How to integrate BAP objectives in current planning instruments on local, regional and state level?
- Whether a mechanism such as a tradable habitat system can be found that allows potential cost-savings to be explored when economic costs of reserves change over time. Research process is now needed to understand under what circumstances the instrument of tradable permits can be implemented in the field of biodiversity.
- Research is needed that defines threatened medicinal species in the area, selects genotypes with high accumulation of active compounds, and works out propagation methods of selected genotypes as well as domestication of propagated material.
- Research has to be done on the various interactions between protected and non-protected areas to engage segregative and integrative strategies. In this context, research on the dispersal ability of indicative species or species groups would provide valuable information.
- The first stepping point in prioritising our collection of information about ecosystems and in searching for the best management practice is the past experience, without which we could not understand the present status and distribution of biodiversity and we will find it considerably difficult to reach a reversal in the biodiversity decrease.

Habitat-based vs. species-based approaches

Per Sjögren-Gulve, Department of Conservation Biology and Genetics, Uppsala University, Sweden

SUMMARY: Moving away from a species-based approach to a sole habitat-based approach in biodiversity conservation is to introduce an unnecessary dichotomization in the discussion. We need to use both.

Richard Ferris and Ant Maddock discuss habitat management for target species and argue that with limited resources and the need for a more unified approach to conserving species, a habitat-based approach would be superior to a species-based one. I argue that there is danger in this dichotomization - we need both.

Coupling this discussion to that on Research needs for the Natural Resources BAP (initiated by Tiiu Kull) and those in the Monitoring, Indicators and Reporting Session, one problem with the habitat-based approach of Ferris & Maddock is that it cannot guarantee that all is well at the species level. And species constitute one of our conservation targets, with reference to the EU directives 79/409/EEC and 92/43/EEC as well as to the CBD. Ferris & Maddock argue that it is unlikely that we need more research concerned with management practices since humans have been managing a wide range of habitats across Europe for centuries, and much is known about the co-evolution of species and communities in response to habitat conditions. I disagree, this line of reasoning has a number of pitfalls. First of all, species responses to habitat management (or habitat quantity or quality) are not linear and deterministic, neither are they independent of the current species composition and relative abundances, state of the surrounding environs, nor of preceding or historic events and conditions. Thus, management without monitoring species responses is insufficient to fulfil our biodiversity conservation goals. Species monitoring is needed to cover spatial aspects of the conservation work: e.g. that habitat is conserved and surroundings managed so that dispersal and recolonization processes work in a "metapopulation" system. Assuming solely deterministic responses to habitat management can be very misleading, and may waste our efforts in erroneous action. For the same reason, individual Species Action Plans should not be written and implemented without considering the effects of the proposed management and actions on other sensitive and vulnerable species in the same habitat(s) – neither should they neglect important habitat aspects. In cases of conflict where the species occur together at several locations, deeper involvement of experts is a good idea to test, monitor and evaluate the effects of 2-3 alternative management strategies on the species at different locations.

My arguments above are not saying that Action Plans for single species is the only alternative. We have an array of choices, and in dialogue between scientists/experts and managers we should choose (or test) what appears to be most appropriate in the individual cases: a single-species AP, species-group or -community AP, substrate- or habitat-focused APs for species groups, disturbance- or management-focused APs for species groups or habitats, or protected areas with appropriate management plans.

Both valuable habitats and selected species need to be monitored. But what species should we monitor? Most likely, indicative species from a number of indicative groups need to be used (Roberge & Angelstam, 2003). For example, I find the nested-species-subsets methodology to analyse species occurrence by patch or fragment using a matrix with presence/absence or relative abundance data, and expanded as in Fleishman et al. (2000), particularly illustrative and promising in the analysis of species co-occurrence patterns and identification of "umbrella species". See also Liam Lysaght's ""Research needs and support services" in BAP-Agriculture, and Klaus Henle's contribution "Structural changes of landscapes" and other discussions in the Monitoring, Indicators and Reporting Session.

Integration of conservation data, motivations and practises

Robert Kenward, Centre for Ecology and Hydrology, UK

The comments by Muessner, Henle and others (on needing more than protected area) and Coates (on how livelihoods connect to biodiversity) go in different ways to the heart of the issue of biodiversity in 2010. There is more to be considered in each case, because a target of halting biodiversity loss may best be met by aiming to reverse it through restoration, and to reverse it widely by encouraging broad public participation at local level.

Protection is not always adequate, not only because of adverse effects in and from areas surrounding reserves, but also because people often respond better to rewards than to restrictions. Emphasis on "stick" without complementary "carrot" can lead to confrontation and avoidance. Thus, proposals to protect farmland habitats can lead to ploughing before the implementation date in order to preserve options on future land use. That contrasts with a remarkable uptake of stewardship schemes that were wisely introduced by UK conservation agencies at a time of declining farm incomes.

The CBD (e.g. Article 11) recognises the importance of adding "incentive-driven conservation" (Hutton & Leader-Williams 2003) to the prior "protect and reserve" paradigm, but there is then the question of how to pay incentives. This is not necessarily a matter of funding whole livelihoods, but for example by payment for a multitude of small measures at field margins, in grazing or crop management, to leverage biodiversity gain by compensating small decreases in intensification. Such funding is now mainly public, but the potential from private sources should not be overlooked. IUCN-UK and Defra recently estimated the value from sustainable use of wild resources in the UK at 25-50% that of agriculture (and excluded tourism, which in totality far exceeds agriculture). However, whether funding is public, private or voluntary, one wants maximum biodiversity gain per Euro (or Pound or Krone!). The challenge is how to optimise conservation of a great variety of interacting species and habitats from as great as practical a diversity of human activities.

One possible solution is to collate all the diverse and disparate socio-economic and ecological information, and deliver it in a practical and user-friendly way to communities and land-users as spatially-specific decision support, so that local users can access all the global thinking. Such technology transfer systems would also aid research, at the least by encouraging standardisation (recommendations of Kovacs-Lang and Perzanowski) of input data (maps, monitoring) and facilitating large scale experiments (e.g. by local variation in stewardship payments). An implementation for Decision Support in Rural Economies (DESIRE) has been proposed in the UK. However, it would maximise integration and economy of scale (and enable useful cross-national analyses) to do this at European level. This cross-cutting theme is also on the table for the European Strategy for Sustainable Use of Natural Resources. It will be good if these strategy threads can be drawn together within DG Environment.

Biodiversity Action Plan- Economic and Development Co-operation

Research needs for the Biodiversity Action Plan on Economic and Development co-operation: opening comments

Juliette Young, Centre for Ecology and Hydrology, Banchory, UK

As a party to the UN Convention on Biological Diversity, the European Community has to fulfil certain obligations to developing countries. These have, amongst others things, led to the EC Biodiversity strategy, followed by the Biodiversity Action Plan (BAP) for Economic and Development Co-operation (EDC), which lays down a number of specific actions and targets to integrate biodiversity into economic, and development co-operation. The BAP consists of 18 main actions, aiming to address priorities set out in the EC Biodiversity Strategy. The purpose of these actions is to integrate biodiversity into policies, programmes and projects being developed through EC economic and development co-operation and help to build the EC capacity to address biodiversity issues as part of economic and development co-operation.

The purpose of this e-conference session is to identify research needs in relation to the Biodiversity Action Plan on Economic and Development Co-operation. There is little doubt that there are at present a number of barriers preventing the implementation of all the actions listed in the BAP such as insufficient funds, general lack of awareness and information, weak links with policies and/or legislation, and unsatisfactory institutional frameworks. This session should therefore not be a list of barriers preventing effective and sustainable economic and development co-operation, but should highlight then research needed to implement the Action Plan.

The research needs highlighted by participants in this session will then feed in directly to the European Platform for Biodiversity Research Strategy (EPBRS) meeting organised by the Irish Presidency in Killarney from the 21-24th April 2004, and from there on to the Stakeholder Meeting in Malahide. The outcome of the Malahide meeting is expected to be a "2010 Delivery Plan" to help achieve the 2010 target of halting the loss of Biodiversity in Europe.

This session on the EDC BAP will be split into three main themes relating to research priorities in terms of structural, procedural and capacity related issues.

Within the first session we will discuss the research needed to successfully integrate biodiversity into economic and development co-operation. Themes within this session will include the need to learn more about biodiversity (the way biodiversity resources are used, the valuation of biodiversity, status of biodiversity and pressures applied to biodiversity, as well as the ability of biodiversity to recover) as well as the role of biodiversity in the alleviation of poverty. Continuing on from this, we will explore research needs for the integration of environmental as well as social and economic aspects into the actions listed in the BAP. Discussion here will mainly revolve around the equitable sharing of biodiversity costs and benefits (Strategic Environmental Assessments, Environmental Impact Assessments, Indigenous Property Rights, patents, access to gene banks etc).

EC Biodiversity Action Plan for Economic and Development Cooperation: Identifying Research Priorities

Krystyna Swiderska, Biodiversity and Livelihoods Group, International Institute for Environment and Development (IIED), London

SUMMARY: The author suggests that research should focus on detailed participatory analysis of the impacts of biodiversity-based approaches and comparison with 'conventional' approaches being promoted in key development, economic and natural resource sectors.

Mainstreaming biodiversity objectives into EC development and economic cooperation strategies and policy dialogue with partner countries is as much a political as a technical challenge – without high level political support progress will be slow and difficult. Those concerned with developing cooperation strategies across different sectors, and those who negotiate cooperation agreements at the highest political level, need to be convinced of the value of biodiversity for achieving poverty reduction and economic objectives.

A good starting point would therefore be to identify examples of approaches that integrate biodiversity, livelihoods and economic objectives in each key sector, and conduct a detailed assessment of their impacts on the ground, including their contribution to food, health, income, livelihood security and ecosystem services (as well as cultural and spiritual well-being). These impacts should then be compared with those of more conventional non-biodiversity based approaches. Such case studies would also serve to demonstrate the types of activities and approaches that can be supported to integrate biodiversity, development and economic objectives. The selection of case study examples could be guided by the principles of the ecosystem approach.

Furthermore, the case studies should also examine the wider policy and governance context in which these examples exist to identify the 'external' conditions needed to better support such approaches and facilitate their wider replication and adoption – for example, secure land tenure, strong representative local peoples' organisations, democratic local governance, effective decentralisation, participatory and adaptive policy processes, flexibility to experiment, feedback from local experience, institutional coordination, and so on. Within a given country, such findings could be distilled from case studies in different sectors and regions.

The research process should itself be used as a means to enhance political support for biodiversity and promote change by engaging with many stakeholders, including current 'power brokers' and 'agents of change', seizing political opportunities, and strengthening the negotiating capacity of local representative organisations. In other words, it should be highly participatory, both in terms of the community level assessment, and the policy analysis process. It should also be tailored to inform key economic and development processes in partner countries such as Poverty Reduction Strategies, macro-economic reforms and agricultural modernisation policies.

In addition to comparison of impacts of biodiversity and non-biodiversity based approaches, deliberative democracy approaches such as 'citizen's juries', scenario workshops or visioning exercises, could also be used to enable poor farmers and communities to assess the implications of different policy options and articulate their preferred vision of the future.

Research needs regarding the successful integration of social, economic and environmental factors into Biodiversity Action Plans

Felix Rauschmayer, UFZ Leipzig- Halle, Germany

The BAP on Economic and Development Co-operation consists of 18 Actions and the arguments for them. The threefold aim of this BAP is to identify priority actions (1) addressing the objectives of the Biodiversity Strategy, (2) integrating biodiversity into policies, programmes and projects being developed and funded through the EC economic and development co-operation, and (3) helping to build the EC capacity to address biodiversity issues as part of economic and development co-operation. It is mainly in the second aim that research is needed or may help to carry out the actions successfully.

Participation is asked for the establishment of national biodiversity action plans, access to genetic resources, protected areas creation and management, integrated land use planning, natural resource management, data gathering and sharing, and monitoring. Looking at these issues and at the projects done in development work, I rather have the impression that research undertaken in development research is more advanced than in intra-European research projects. One seems to accept more easily that participation is needed in development countries than in developed countries. This is probably due to the external perspective of European researchers on developing countries, but also to the direct relationships and dependencies of local populations on biodiversity-related issues - in Europe, this relationship is less direct, and generally populations are less dependent on their direct natural environment. Another remarkable difference is the freedom of dogmatic approaches in projects in developing countries where factual constraints and an apparently higher endeavour to reach a socially positive output impose choices that are not necessarily consistent with rigid theoretical approaches. Not being an expert for development research, this rather leads me to the suggestion that intra-European biodiversity research can learn from developing countries oriented research: more participation with less disciplinary dogmatism.

Another item I want to highlight is "capacity building", another recurrent theme in the actions of the BAP. Here, capacity building is mostly linked to interdisciplinary tasks such as national biodiversity action plans, integrated land use planning, or university and research. Here, it might be useful to spend some money for management studies in order to create learning, interdisciplinary institutions, open for participation and local non-scientific knowledge. Not only developing countries, but also EC countries might profit from such studies (or rather from such institutions).

My third item directly relates to one specific action (10): "The EC will support research efforts in developing countries, which clarify the costs and benefits of different patterns of biodiversity management for different groups of stakeholder, in particular the rural poor, and taking into account the importance of biodiversity to rural economies". The importance of equitable sharing of benefits and costs should not be seen as a zero-sum-game, but different patterns of management will result in different heights of costs and not only in a different distribution. More research into institutional economics, and into co-management of natural resources may help not only in developing, but also in industrialised countries where management options seem to be more fixed to the existing legal framework.

RE: Research needs regarding the successful integration of social, economic and environmental factors into Biodiversity Action Plans

Rehema White, Centre for Ecology and Hydrology, Banchory, UK

I have also noted the more detailed form of participation usually undertaken in developing than developed countries and agree that we can learn from those processes. Felix Rauschmayer suggested that more participation occurs in developing countries because of the external perspective of European researchers in developing countries and a more direct

dependence of local people on biodiversity in such countries. I would propose that additional reasons were cultural differences (depending on the country) and the practicalities of needing people who use the resources daily in the lack of strict law enforcement to be on the side of policy. I do not feel, as he suggested, that there is freedom from dogmatic approaches in developing countries. Perhaps the lack of use of detailed methodologies for participation in developed countries is also due to the facts that participation has become a 'buzzword' and is often not implemented thoroughly (Bell and Marzano, BAP EDC below); there is plenty of legislative requirement for participation in Europe. In developed countries we often use representatives, committees and task forces but perhaps some cases require broader representation within stakeholder groups (as often occurs in developing countries). In addition, there is sometimes a feeling that some methods designed for developing countries would be patronising for people with better literacy skills but many of the methods (if used sensitively) encourage free thinking, inclusion of local knowledge, active research, space for relationship building and other relevant aspects. We are planning to test some of these methodologies to expand stakeholder input to some conservation issues in Scotland. Have others made such comparisons?

Research needs on the role of participatory processes in terms of legislation and policy creation

Sandra Bell and Mariella Marzano, Department of anthropology, University of Durham, UK

SUMMARY: More research and experimentation needs to take place in order to refine participatory research to support the development of effective and meaningful policies for environmental governance.

"Global environmental protection begins at the community and bioregional level- the level where complex living systems are most interdependent and vulnerable. Local water-shed, ecosystems and microclimatic conditions are among the primary objects of bioregional protection, and their alteration by human activities is much easier to understand from the vantage point of local communities than from the macro perspective of global ecology" (Hempel, 1996).

Even if one does not agree with this view that environmental protection should begin at the local level, no one would disagree that the involvement of local people is important for research, policy and legislation. Increasingly, the way into research and development at the local level is through what is called "participation". Indeed these days the term has reached the dubious status of being a "buzzword". Much of what passes as 'participatory' research, however, amounts to no more than co-opting people into projects designed and led by "professionals" (Cornwall and Jewkes, 1995). Despite it becoming so diffuse as to sometimes appear meaningless, we would argue that the notion of participation is important. For participation to work for everyone there needs to be greater collaboration between all stakeholders, however diverse, including scientists and policy makers. This is the essential formula that can make a significant contribution to governance aimed at sustainability and the conservation of biodiversity.

What we mean by collaboration are long-term commitments to negotiation and ongoing processes of mutual involvement and communication. It takes a lot of time to build strong networks of trust and co-operation on which successful participation is based. The emphasis in participatory research is on process not outcome, which means that as things stand it is not particularly amenable to the world of policy making which generally wants quick and concrete results from the research on which it draws.

The big question is how to devise, for example EU level policies, that appear pertinent for local concerns and acceptable to all parties because they have derived form their own concerns and interests.

Effective policy making could be about allowing for the interaction and negotiation of identities. These depend on being able to encompass different kinds of knowledge and competing epistemologies and integrating them into regulation and legislation. The location for this kind of integration is likely to be in the realms of civil society, which Edward Weber describes as "the intermediate realm of politics that lies between individuals and government" (Weber, 2003). This is not an idea realm, it is one where people are hugely diverse, split into factions and often simply do not care, but it is probably the most realistic place to start.

There is a need to discover and develop new research methods, to experiment with participatory initiatives, and chart existing successes such as aspects of the Wise Use of Floodplains LIFE Project (www.floodplains.org). Investing the necessary time to bring people together at the level of civil society should not be beyond the capacities and imagination of both social and natural scientists.

RE: Research needs on the role of participatory processes in terms of legislation and policy creation

Rehema White, Centre for Ecology and Hydrology, Banchory, UK

I found the paper on 'Research needs on the role of participatory processes in terms of legislation and policy creation' really interesting and agree particularly with the statements describing true participation and the fact that lip service is common in practice.
I would see a further research need in this area as being: Does participation cost? There is a perception by policy makers that participation is an expensive, time-consuming process. However, some research in developing countries indicates that good participation can actually save time and money once stakeholders are trained in participatory methods. (By stakeholders I include policy makers themselves, researchers, facilitators, community and community groups). My feeling is that participation undertaken well leads to better stakeholder awareness of the broad range of issues involved in development of a particular policy; includes stakeholders in research; involves local people in planning hence including often valuable local knowledge; can feed back to improve pilot programmes; and ultimately leads to better efficacy and acceptance of policy. Policy makers should thus see participation as an investment not an additional cost. Are there sufficient European studies that examine the long term cost benefits of participation?

Research needs for the Biodiversity Action Plan on Economic and Development co-operation: summary of session 1 and introduction to session 2

Juliette Young, Centre for Ecology and Hydrology, Banchory, UK

Contributions this week have very much focussed on the need to integrate social, economic and environmental factors into the Economic and Development Biodiversity Action Plan. With this purpose in mind, participants strongly advocated the role of participatory processes. Although Felix Rauschmayer noted in his contribution that the concept of participation seemed better integrated in development research, Sandra Bell and Mariella Marzano urged for more participation, involving long-term collaboration by building up trust and communication with all stakeholders. Their contribution focussed primarily on participation in terms of the development of legislation and policy and called for the integration of different types of knowledge into legislation and regulation. This process calls for a greater investment of time and energy in experimenting with participatory approaches, building on past participatory successes and developing new research methods.

On the theme of capacity building, Felix Rauschmayer called for the need to develop management studies to create "learning, interdisciplinary institutions, open for participation and non-scientific knowledge" in both EU and developing countries. He also highlighted the issue of benefit sharing, urging for more research into institutional economics and the co-management of natural resources.

In her contribution, Krystyna Swiderska highlighted the fact that mainstreaming social, economic and environmental factors into EC economic and development co-operation would require political will, which would, in turn, call for that politicians being convinced of the role of biodiversity in poverty reduction and economic objectives. She suggested that research in this field should focus on analysing past integrative approaches and compare these to more conventional non-biodiversity based approaches, all the while considering the whole policy governance context in which these case studies occur. This approach would inform politic ians, engage local people and positively increase the value and role of biodiversity in economic and development cooperation.

In the next session we will of course be continuing to explore the issue of how to integrate biodiversity into economic and development cooperation, but we will also be exploring the procedural issues, including research needs for information and awareness building, co-operation between major organisations and individual countries and equitable knowledge exchange.

Forest biodiversity research needs for the Biodiversity Action Plan on Economic and Development Co-operation

David Kaimowitz, Centre for International Forestry Research (CIFOR)

SUMMARY: The author welcomes commitments outlined in the BAP EDC, and recommends more research on the biology of forests found in complex land-use mosaics and the policy tools that could effectively influence how they evolve. Research should also focus on the magnitude of the factors affecting forest biodiversity, and possible policies to mitigate potential negative impacts. Finally, he highlights research needs relating to the magnitude, location, and trends in forest resource use by poor rural people as well as solid information on the perceptions of the rural families about how important forest biodiversity is and what they think should be done to maintain it.

The Commission's proposed Biodiversity Action Plan on Economic and Development Co-operation reflects the best aspects of current international thinking about these issues. CIFOR strongly endorses its commitment: To adopt an ecosystem perspective and a multi-sectoral approach; To encourage full stakeholder participation; To emphasize the links between biodiversity and poverty reduction; To ensure that all EC development assistance is consistent with the EC's biodiversity objectives; and to see research and capacity building as key elements of its plan.

To effectively implement what the Commission is proposing will require great improvements in developing countries' knowledge and capacity in each of these areas.

- Most research on forest biodiversity has focused on large primary forests. However, the forests of the future in most developing countries will be largely forest fragments, secondary forests, logged-over forests, and agroforests, found in complex land-use mosaics. We need to know much more about the biology of such land use mosaics and the policy tools that could effectively influence how they evolve.
- We know a fair amount about the general aspects of how macro-economic, trade, financial, agricultural, and transportation policies affect forest biodiversity, but much less about the magnitude of these effects or what policies might be appropriate for mitigating any potential negative impacts. Most developing countries have few professionals trained to address these issues.
- With regards to poverty, we know that for many poor rural people forests contribute significantly to their livelihoods, by providing income or income equivalents, serving as "safety nets" (gaps fillers or insurance) in times of particular need, and supplying valuable environmental services such as clean water, soil nutrients, pollination, forage, and weed control. However, much of the information is anecdotal or based on small samples. We know surprisingly little about the magnitude, location, and trends of these contributions and what policies would be most likely to increase them (or at least keep them from declining). We also lack solid information on the perceptions of the rural families themselves about how important forest biodiversity is and what they think should be done to maintain it. Again, these are areas where most developing county professionals have limited experience and training.

CIFOR believes that the European Commission and European research and education institutions are well placed to support developing country efforts to increase their capacity to do research and design effective policies in these areas. We salute your existing efforts in these areas, and we hope that more efforts go in these directions in the future.

Biodiversity Action Plan on Economic and Development Co-operation: research needs concerning IPRs.

Maria Fonte, Dipartimento di Teoria e Storia della Economia Pubblica, Università di Napoli "Federico II", Italy

SUMMARY: Research is needed for the study of the contribution of local rural communities to conservation and innovation in local variety development and for research that identifies instruments able to maintain and strengthen their capacity to do so, while valuing biodiversity as a resource for development.

On the issue of IPR for genetic resources, the BAP-EDC (Biodiversity Action Plan on Economic and Development Co-operation) places itself in a framework similar to the CBD. It takes into account only regimes of IPR based on private ownership and overlooks both collective and public goods. Actions stress "capacity building" " to be able to negotiate with government and private enterprise". Research is needed that studies the contribution of local rural communities to conservation and innovation in local variety development and that identifies instruments able to maintain and strengthen their capacity to do so. The BAP-EDC also needs to be updated in order to take into account the Multilateral System of the International Treaty on Plant Genetic Resources for Food and Agriculture (IT-PGRFA) signed in November 2003, which recognises for specific plant genetic resources the status of "public good" and gives emphasis to the role of farmers for their conservation and improvement.

Genetic Resources are a good example for illustrating a "comedy of the commons", as Carol Rose would say. While collective property regimes of management have preserved biodiversity, systems based on individual (or private) property rights led to erosion of biodiversity. Research is needed that clarifies the basic concepts of "local/rural/indigenous community" and of "local variety", the contribution of local varieties of plants and animals to the economic development of rural communities and how it is possible to acknowledge, from a juridical point of view, collective good, taking into account community habits, traditions and knowledge.

While at present the enforcement of private IPR are justified in the name of the necessity to create an incentive for (formal) innovation, any measure in this direction should be evaluated in relation to the threat it represents for the conservation of biodiversity. In particular, any provision forbidding the free exchange of seeds operates against the secular habits of farmers in rural communities, the same habits that contributed to the conservation and improvement of biodiversity.

Are conservation and innovation in opposition? What informal system of innovation may teach to the formal ones? Is there a conflict between customary and formal law? Interdisciplinary research is needed to respond to these questions.

Research needs for the successful integration of social, economic and environmental factors into Biodiversity Action Plans

Frank Wätzold, UFZ Leipzig-Halle, Germany

SUMMARY: Research on governance structures, institutions, instruments to encourage a positive involvement of the private sector in biodiversity conservation, and on interaction between biodiversity and other policies is needed from an interdisciplinary perspective involving representatives from developing countries.

The following hypotheses are meant more to stimulate discussions than to provide final conclusions:

1.) We need to develop mechanisms to ensure that the effects of EU-policies not directly related to biodiversity but affecting biodiversity (e.g. agriculture, free-trade) in developing countries are properly taken into account when such policies are developed. Similarly, mechanisms are needed that adequately consider the social and economic effects of biodiversity policies in developing countries.

2.) The Biodiversity Action Plan rightly states that the private sector of industrialised countries can play an important role by making positive investments in line with the maintenance of biodiversity in developing countries. It is not explicitly stated - but equally important - that private investment can be highly detrimental to biodiversity. We need to develop mechanisms that support positive private investment and deter negative private investment. For example, there should be a (institutionalised) way to make positive as well as negative behaviour known to the general public.

3.) An improved understanding of adequate governance structures and institutions that are best able to conserve biodiversity and ensure social and economic development is needed. In particular, we should to a much greater extent explore the potential to successfully implement economic instruments and incentives to conserve biodiversity. Such incentives and instruments tend to be much better for economic development than command and control instruments.

4.) Generally, research that addresses the issue of the successful integration of social, economic and environmental factors into Biodiversity Action Plans should be interdisciplinary and focus on the solution of a particular policy problem. The disciplines to be integrated in the research should be selected on the basis of what is needed to comprehensively solve the problem. Of course, representatives from developing countries and, if necessary and useful, local communities should be included.

Four internalisations: promoting institutions in support of biodiversity and development

Ian Hodge, Department of Land Economy, University of Cambridge, UK

SUMMARY: Institutional change can be a critical cause of damage to biodiversity, while new institutions can operate in support of both biodiversity and development. In many circumstances biodiversity is lost because nobody has an incentive to conserve it. This note suggests four circumstances in which institutional change may be promoted to 'internalise' biodiversity values. We need to explore the ways in which such internalisations may be achieved in practice. In each case, the aim of institutional change is to encourage those whose decisions and actions influence the status of biodiversity to benefit directly from its conservation. While there are overlaps between the cases described, they illustrate the general directions for change. There may be other types of case too.

1. Ensuring access to future production values: The protection of biodiversity often depends on the conservation of the production base; in some cases the biodiversity is the resource base. Managers of the resource will operate with long-term conservation in mind where they have confidence that they and their successors will be able to benefit from resource values in the future. They must also have sufficient current income in order to be able to afford to adopt sustainable techniques in the present. Thus, fishermen must have clearly defined rights to a share of the catch from a fishery. They must have confidence both that this right will be respected in the future and that non-rights holders and other factors will not excessively diminish future potential. The same principles apply to the conservation of other productive resources, such as forests or soils.

2. Giving legal status to traditional uses: Some products of biodiversity are used under traditional and informal arrangements and these uses can have significant values to local communities. However, where local communities have no formal legal rights to these uses, they may be displaced without their agreement or compensation. If such uses were given such a legal status, then those wishing to introduce new developments would at least first need to buy out the existing traditional uses. Further, the absence of formal rights increases the uncertainty as to the future availability of the resource and so discourages sustainable use.

3. Sharing in new biodiversity opportunities: Economic developments can also increase the economic incentives to support biodiversity whether through the discovery of new chemicals or genetic material, or the creation of new tourism enterprises. However, there needs to be a link between the economic values gained from biodiversity and those whose decisions influence its conservation. Thus local communities need some formal rights in and engagement with the development of the economic initiatives. Those who see realistic prospects for economic gain from biodiversity will be willing to take an active role in its conservation. This can also be advanced through product standards and branding.

4. Internalising international concerns: Values of biodiversity are appreciated worldwide. Some elements of the environment have a high profile and are recognised and valued by populations in foreign countries. Sometimes this is solely an existence value or sometimes there are physical links perhaps due to the migration patterns of particular species. Thus conservation actions in one country can provide benefits in others. Institutional arrangement should recognises these interrelationships and seek means whereby the beneficiaries can contribute financially towards the costs of conservation.

These internalisations would not guarantee that all or even a desired amount of biodiversity was conserved. In practice it will not always be possible to internalise all values; indeed we recognise that these types of incentives are generally absent specifically because of the difficulties in introducing and enforcing property rights. There are also issues of the relative power of different sectors of the community and we may anyway debate as to whether even complete internalisation would generate the desired outcomes. Sometimes too the protection of biodiversity incurs a real cost to production values. A herd of wild elephant

can do a great deal of damage to a farmer's crops. But more often biodiversity suffers from neglect and indifference. Such internalisations would help to bring practical incentives into line with the more generally desired outcomes. And often, the conservation of economically valued species will go hand in hand with broader conservation outcomes. Research needs to investigate new ways of internalising biodiversity values and share experience where this has been achieved.

BAP EDC: Research needs so far…

Juliette Young, Centre for Ecology and Hydrology, Banchory, UK

Below is a list of research priorities identified by participants during the first three weeks of the e-conference concerning the Biodiversity Action Plan on Economic and Development Cooperation.

- Research on methods to increase participation, involving long-term collaboration by building up trust and communication with all stakeholders.
- Research on the cost and long-term benefits of participation
- Increased integration of different types of knowledge into legislation and regulation experimenting with participatory approaches, building on past participatory successes and developing new research methods.
- Develop management studies to create "learning, interdisciplinary institutions, open for participation and non-scientific knowledge" in both EU and developing countries
- Research into institutional economics and the co-management of natural resources
- Analysis of past integrative approaches and comparison with more conventional non-biodiversity based approaches, all the while considering the whole policy governance context in which these case studies occur.
- Research on the biology of forests found in complex land-use mosaics and the policy tools that could effectively influence how they evolve.
- Research on the magnitude of the factors affecting forest biodiversity, and possible policies to mitigate potential negative impacts.
- Research needs relating to the magnitude, location, and trends in biodiversity resource use by poor rural people as well as solid information on the perceptions of the rural families about how important biodiversity is and what they think should be done to maintain it.
- Research into the contribution of local rural communities to conservation and innovation in local crop variety development and for research that identifies instruments able to maintain and strengthen their capacity to do so, while valuing biodiversity as a resource for development.
- Development of mechanisms to assess a) the effects of EU policies not directly related to biodiversity on biodiversity, and b) the effects of biodiversity policies on socio-economic factors in developing countries
- Development of mechanisms promoting positive private investment and deterring negative ones
- Potential for economic instruments and incentives in biodiversity conservation
- Research on ways in which to internalise biodiversity values (access to future production values, legal status given to traditional uses, benefit sharing, internalising international concerns).

Biodiversity Action Plans and international co-operation

Jurgen Tack, Belgium Biodiversity Platform

DG International Co-operation is responsible for the international co-operation, but their officials dare to say developing countries are not interested in biodiversity. DG INCO officials are not able to calculate how much money was spent on biodiversity in their programmes. How will we be able to develop biodiversity indicators if we are not capable of calculating our financial efforts in this field? DG Research has money for biodiversity research but advises Networks of Excellence, Integrated projects and STREPS not to add institutes in developing countries to their partner lists. The 6th Framework Programme should increase Europe's competitiveness, not the competitiveness of Africa, Latin America or Asia! DG Environment, together with the EEA and the ETC Biological Diversity reports on the present status of biodiversity within Europe, develops European indicators and monitoring schemes without any reference to what is happening outside Europe. The loss of biodiversity is not restricted by our national boundaries! But it should be clear it is not restricted by European borders either. Didn't the EU as well as its Member States sign the Convention on Biological Diversity? Isn't Article 18 Paragraph 2 of the CBD obliging the signatories to assist developing countries in their battle against biodiversity loss? Do we really think we can alter the loss of biological diversity by 2010 within the EU without considering what is happening outside the EU?

But whom should we blame? Organising stakeholder meetings and writing biodiversity strategies and BAPs is only a first step. We should also consider that conserving nature requires money and technical expertise, both of which are lacking in most tropical regions. The average annual global expenditure on nature reserves by governments and foreign donors is presently US$ 453 km^2, but only US$ 93 km^2 is spent on reserves in the tropics. With so limited budgets biodiversity researchers should focus on key issues, key processes and key ecological indicators. They are carrying an enormous responsibility. They should be aware that scientific credibility is at risk when they are promoting 'pet' issues at the cost of real priorities.

Evaluating the EU biodiversity strategy and the BAPs gives us (researchers and policy makers) the opportunity to take up this responsibility. However, I would like to warn not to make the mistake to use those instruments to promote research on specific ecosystems, on specific species, on specific methodologies or on specific regions. More than ever the real priorities should be discussed loose of all personal interests.

Participatory data gathering and sharing

Scott Jones, University of Wolverhampton, UK

I agree with Mariella, Sandra and others who advocate greater emphasis on participation, and research into participatory processes. Contributors also highlight the nature of data, the link between knowledge and identity, and the fact that integrating different data (e.g. 'customary knowledge,' 'western scientific knowledge') requires negotiation not only on the 'facts' but on the identities behind those facts. I also agree with David's upbeat endorsement of the BAP on EDC reflecting "the best aspects of current environmental thinking…." and it's good to read about CIFOR's commitments and elaboration of research and capacity building needs.

Then we come to the two verbs "gathering" and "sharing." The words sound comforting. But the reality of obtaining and disseminating data in the science business is perhaps is a little more competitive and fretful. Participatory approaches are supposed to solve problems of 'data extraction' where outsiders 'gather' data for outsiders' purposes. But the pressures of time, money and research grant reporting milestones can leave even the most ethical and responsible researcher conflicted and struggling.

As Caspian Richards suggests (Livelihoods, biodiversity and conflict resolution), academics are themselves conflicted about the implications of "participation" within the research community. Not that 'local people,' 'village community,' and 'poor rural people' contexts are havens of effective participation, good governance, gathering and sharing for the collective good. Local politics, differences in status, wealth, gender, age and education provide a social environment as diverse as the biological diversity we seek data about. Just as chaotic, just as wonderful, just as demanding to engage with in any serious research effort on participatory data gathering and sharing.

The question "What are the research needs for participatory data gathering and sharing" is not a question for scientists alone. It actually needs to be negotiated in a participatory way. Yes, I know, what is 'participatory?' That itself is a researchable, context-related question, but at least has a strong literature and some good case studies to draw on. The main point is that we (who are 'we' by the way?) need to research the context within which the question itself resides. The context includes questions of scale (geographic and temporal), power relations (within and among different levels), roles (who does the research, why, under whose authority, with what legitimacy, who shares data and how, where do the data actually end up), rights (including IPRs [Maria Fonte, Research needs concerning IPRs], and other things that span research ethics, and the 'nuts and bolts' of actually doing research.

We face another key research question that links with several contributors' comments. What data are "we" trying to research in a participatory way? The data that are required to implement the EDC BAP include not only data on the biodiversity (the soil, animals and plants) according to international classification systems and local systems, but other data that have more to do with social and economic development. If, as Caspian suggests, academic research consists "… of two distinct types of people: people who study nature (biodiversity), and people who study people (livelihoods)" then how these folks might come together to "do participatory research" becomes another research question.

This also ties in with David's points about capacity building. Tensions between social scientists, natural scientists and local peoples' customary knowledge probably exist in all countries. And capacity building needs to recognise and respond to issues of legitimacy, mutuality and integration of different epistemologies and other things, as well as technical ability. Krystyna's fourth paragraph helps anchor the question on "Researching the research process" in a really useful, practical way whereby the research process itself can engage stakeholders in a dialogue, enhance political support and build capacity for self-representation (Krystyna Swiderska, EDC BAP: Identifying research priorities).

Research questions:

To implement the EDC BAP from a 'participatory data gathering and sharing' perspective, then, there seem to be a number of overarching research questions that concern scale, context and research traditions. This has as much to do with linkages between things

(e.g. linkages among practice, strategy and policy at different geographic, political administration and time scales; linkages among natural science, social science, and local research philosophies) as within any of these. There exist excellent examples of good policy that cannot be implemented because of poor linkages with strategy or because practice-level capacity doesn't exist. Equally, there are superb practices on the ground that cannot be scaled up or inform policy debates because of ineffective linkages with strategy or policy makers. So, a starting list for me includes questions like:

- How can we approach and reconcile the legitimacy, power, precision and validity that different research instruments and approaches might connote for different stakeholders. In particular, how can we engage with Action Research and Participatory Appraisal approaches in ways that support and fit with more positivist research traditions?

- How can we best research the context? What are the rules of the game for participatory research? How can 'these data' (independent, neutral, objectively verifiable?) and the process for gathering and sharing them, secure legitimacy and acquire meaning along different dimensions (social, legal, economic, political, cultural, environmental/biodiversity) for different stakeholders at different scales?

- There needs to be research on power relations (whose data, how researched, for what purpose, which data have priority and who decides, …). Just as statute law asserts primacy over customary law, should international and national science assert primacy over customary knowledge?

- What aspects of current approaches to natural resources conflict analysis and multi-stakeholder partnerships might be useful in empowering local people in development processes that go beyond "participatory data gathering and sharing" on a space by space basis.

- How can we research the opportunities and constraints in Participatory Approaches (PA) at all stages of the project cycle, not just in discreet "let's get biodiversity data" packages?

- How can we engage with PA strategically, rather than simply on a project basis, to provide policy relevant information, and create pathways for policy dialogue vertically as well as horizontally?

- What challenges and opportunities face participatory, biodiversity-related research in urban and peri-urban contexts?

- Research is needed into confidentiality and data sharing issues (biodiversity data useful for social development and conservation may be used unscrupulously by businesses seeking commercial gain)

- Considering gender, scale, power and other issues, how might participatory research inform ways of operationalising the seven BAP-EDC guiding principles (for example, fair and equitable sharing; inclusive and responsive institutions)?

- What aspects of political and professional will need researching, to consider tough questions like attitudes, motivations, career and power?

Sustaining Livelihoods

Research needs for Sustaining Livelihoods: opening comments

Rob Tinch, Session chair, Macaulay Institute, UK

In the finest traditions of the EPBRS, documents start with an apt and pithy quotation, often culled from a great work of science or classic literature. For example: *"I saw a man in the street, and the back of his anorak was leaping up and down, and people were chucking money to him. I said 'Do you earn a living doing that?' He said 'Yes, this is my livelihood.'"* (Tommy Cooper)

Alternatively: *"The degradation of the environment, in its various forms, is by far the most serious problem that threatens the life support systems, and the livelihood of the poorest of the poor. The loss of biodiversity threatens our food supplies, opportunities for recreation and tourism, and sources of wood, medicines and energy. It also interferes with essential ecological functions: destabilizing ecosystems, and weakening their resilience and ability to deal with natural disasters such as floods, droughts, and hurricanes, and with human-caused stresses, such as pollution and climate change. The 2010 target provides a clear focus for individuals, countries, institutions and organisations to work together to ensure that the rate of loss has significantly reduced at all levels."* (Hamdallah Zedan, Executive Secretary, Secretariat of the Convention on Biological Diversity.)

Clearly that there is a strong, important link between environmental degradation, including biodiversity loss, and the opportunities open to humans now and in the future. It is also clear that the effects are most keenly felt by the poorest groups, who are more likely to depend directly on biological resources for their livelihoods, and/or who cannot afford to take measures to defend themselves against adverse conditions. Further, the feedback from the ways people try to cope with environmental degradation may themselves exacerbate the damage caused.

Are the links between biodiversity and development adequately reflected in conservation and development policies, which may often impact on both sets of objectives? Where do conflicts between conservation and development objectives arise? How can we encourage positive links and reduce conflicts? Where are the key gaps in knowledge, and what research is required to fill them?

During the first week of this e-conference, we will explore the implications for research of the links between livelihoods, poverty and biodiversity. Since this crosses disciplinary boundaries, it may involve a degree of going back to first principles, and agreeing terms of discussion. The first keynote contribution, by John Cameron of the School of Development Studies, University of East Anglia, is entitled "What is development? The need for an ethical dimension in research." It contains some important and interesting insights which should provoke debate, and which may provide a foundation for agreement between the biodiversity and livelihoods research and policy communities. What are the implications of John's arguments for the research agenda?

In the second week, we will move on to consider the concepts of sustainability and resilience as they relate to biodiversity and to livelihoods. Sustainable livelihoods and biodiversity may be related by quite fragile links, which may be under threat from drivers such as climate change. The measurement or assessment of sustainability and resilience, and the means of linking the social and biological aspects of assessments, are key to formulating appropriate policies. What research is needed here?

Finally, we will look more directly at the policy level, focusing on resource management, biodiversity conservation and sustainable livelihoods. Under certain policies, there may be conflicts between objectives; for example, undesirable impacts from applying market-based solutions in "traditional" contexts. Recognising and avoiding these problems, and devising appropriate tools and policies for different situations, present important research challenges.

What is development? The need for an ethical dimension in research

John Cameron, School of Development Studies, University of East Anglia, Norwich, UK

SUMMARY: Research looking towards large-scale implementation of its findings always needs to be procedurally rigorous in experimentation and have full exposure to open deliberation to be ethical in protecting bio-diversity and sustainability.

Development is what people value as improvement in the human condition. Improvement is assessed in terms of the conditions that people have good reason to value. These reasons to value may make universal claims in terms of desiring reduction in deception (including scientific obfuscation) and coercion (including aggressive patenting) for people in their immediate lives. But in practice, most values will have specific local meaning and these need to be understood if we are to understand what constitutes development for that group of people.

Anthropocentric values lead to ethics in terms of prescriptions to actively promote the good and avoid harm with respect to all human beings. In inter-generational ethics, harm can be seen as loss of opportunities for future human generations, good as sustaining their opportunities. Maintaining biodiversity can be seen as ethical from this standpoint – to which may be added an ethical aesthetic of the value of experiencing awe and the sublime with the prospect of nature in its full prolific glory.

From this ethical perspective, a strong concept of sustainability involves valuing all life forms and a stance that condemns acting in a way that threatens extinction of any life form as it removes an experiential opportunity for all future generations. All research needs to be seen in the light of its threat to existing life forms – though arguably an anthropocentric ethics would accept the destruction of life forms that unambiguously damage human beings.

A more complex ethics applies to creation of new life forms by genetic engineering – arguably these could increase opportunities for current and future generations and be an ethical good in terms of expanding opportunities to live good lives. The anthropocentric ethical argument would be concerned that such research creates life forms that could be destructive of other potentially useful, pre-existing life forms – this would suggest an ethical basis for exercise of the precautionary principle and very, very carefully contained experiments before any genetically engineered life forms were brought into uncontrolled interaction with other life forms.

This ethical argument combines the desirability of respecting people's contextual values in any assessment of development with a universal principle that human beings should avoid extinctions and take precautions in research that increase risk of extinction with respect to existing life forms.

The mixture of offering full opportunities for public deliberation on what constitutes improvement in the human condition combined with strict procedural rules for research is offered as an ethical position consistent with both sustainability and bio-diversity. Research is then ethically possible if it demonstrates the precautionary principle in its experiments; use of that research is then ethically possible if it passes the test of full public deliberation.

The precautionary principle in sustainable livelihoods and biodiversity conservation

Rosie Cooney, The Precautionary Principle Project: Sustainable Development, Natural Resource Management and Biodiversity Conservation. A joint initiative of IUCN, Fauna & Flora International, TRAFFIC and ResourceAfrica

SUMMARY: No human use or exploitation of the environment is free from risks to biodiversity. The history of biodiversity loss and threat illustrates that damage to biodiversity and the livelihoods dependent on it is often unpredicted and may in general be unpredictable. Managing uncertainty and unquantifiable risk is a fundamental challenge to systems of regulation and management. In recent years a major response of environmental law and policy has been widespread adoption of the precautionary principle, or precautionary approach. While it exists in many forms in different contexts the core idea is that uncertain, unpredictable risks must be anticipated and managed. Where there are risks of serious or irreversible harm, scientific uncertainty should not be used as a reason to avoid or delay taking action to avoid it.

This principle has intuitive appeal as a prudent and responsible approach to safeguarding the biodiverse, healthy ecosystems on which all humans rely directly or indirectly. It is now widely and increasingly accepted in environmental law and policy at international, regional and national level, including as a very broadly applicable policy principle within the EU. However, in practice, the principle is proving ambiguous in content and highly controversial in application. A key point of contention is its role in contributing to or conflicting with livelihood needs and priorities. Precaution is usually interpreted and applied to restrict human economic and livelihood activities, and such restrictions (by definition) cannot be justified by unambiguous scientific evidence, providing fertile ground for dispute.

Incorporation of the precautionary principle into biodiversity conservation policy raises particular issues. First, the meaning of precaution may be unclear where the causes of biodiversity loss are complex and multiple. Averting one risk may exacerbate another, and it is frequently unclear what the "risk-averse" strategy actually is. Second, precaution is often uncritically interpreted as "protectionist", requiring strategies that prohibit or restrict access to wild species, including wild meat, fisheries, and forest products, and restricting their utilisation and trade. This may not always be appropriate, and may have a range of negative consequences on livelihoods: such measures may cut off or restrict particular livelihood strategies, or erode markets for living natural resources, jeopardising sustainable natural resource management. Less developed countries are particularly heavily reliant on living natural resources, and within these countries the livelihoods of some of the poorest and most marginal groups, including rural poor, are the most dependent. Third, livelihood implications will be crucially affected by environmental and resource governance, in particular whose perspectives and voices are represented in decision-making, and who bears the costs of precautionary policy. Precautionary restrictions may often reflect environmental priorities and perceptions of risk determined by urban, Northern or rich/powerful constituencies, rather than reflecting the requirements for sustainable livelihoods of resource users themselves.

Key research questions are:

Does biodiversity conservation policy adequately recognise and deal with scientific uncertainty and risk?

Can implementation of the precautionary principle have negative livelihood consequences?

How can the precautionary principle be operationalised to both further biodiversity conservation and support sustainable livelihoods?

Participation in research and conservation

Jorgen Thomsen, Critical Ecosystem Partnership Fund, Conservation International

SUMMARY: To foster greater understanding of the relationship between conservation and sustaining livelihoods, we must increase our knowledge of the processes that enable healthy ecosystems to provide broad-scale ecological services and of the economic value of those services to nations and their citizens.

The Critical Ecosystem Partnership Fund - a joint initiative of Conservation International, the Global Environment Facility, the Government of Japan, the John D. and Catherine T. MacArthur Foundation and the World Bank - aims to advance conservation of biodiversity hotspots in developing countries. Our strategy is underpinned by a common understanding that biodiversity conservation and economic prosperity are intrinsically linked. There is a growing body of case studies and research on the linkages between biodiversity conservation and human welfare. These linkages have also now been greatly reinforced and elevated by the Millennium Development Goals and, for example, decisions at the World Summit on Sustainable Development.

To foster greater understanding of the relationship between conservation and sustaining livelihoods, we must increase our knowledge of the processes that enable healthy ecosystems to provide broad-scale ecological services and of the economic value of those services to nations and their citizens. Three research topics that may yield new information to close these knowledge gaps are 1) identifying the core ecological processes supporting ecosystem services, 2) understanding the effect of change on these processes and 3) defining economic valuation techniques for assessing the monetary value of ecosystem services.

Identifying the core ecological processes supporting ecosystem services: Healthy ecosystems provide free products and services vital to the health and well being of communities and entire nations. These include, for example, watershed management, air filtration, erosion control and pest management. But little is known of which natural resources provide necessary ecological services and, more specifically, the complex interactions between species that make these services function effectively. The impacts upon ecological processes can also extend far beyond our traditional definitions. In the Peruvian Amazon, preliminary research has shown a link between deforestation and increased rates of malaria. Which processes in the forest ecosystem deter or slow the spread of malaria and other diseases?

Understanding the effect of environmental change on these processes: The effects of human-induced environmental change on ecological processes and hence upon financial health and well being of economies and people can be dramatic. Further research is needed to understand what types of landscape-level impacts result from significant changes, such as land conversion and climate change, and how these modifications affect the balance of ecosystem components that interact to provide ecosystem services. The findings could enable proactive mitigation and adaptation strategies as core components of both biodiversity conservation and development plans.

Defining valuation techniques: If ecosystem services and the biodiversity that supports them is to be truly valued and factored into national policies and programs, each country, especially those in developing stages, must be able to clearly see the value of ecosystem services to their economy. Through greater research into effective methodologies for standardizing valuation techniques, the global community would be able to create scientifically sound and interlinked development and conservation programs based on the linkages between biodiversity, economies and livelihoods. An emerging consensus is that such methodologies need to extend beyond efforts to value biological resources as market or export commodities to valuating the economic impacts of the gradual erosion or elimination of these services that result from removal of species and other change.

Nothing to report?

Rob Tinch, Session chair, Macaulay Institute, UK

SUMMARY: Does the lack of comment on sustainable livelihoods reflect a tacit and/or resigned acceptance of misery and vice as the current solutions to human overpopulation, and an over-riding concern with conservation for its own sake, or for the benefits primarily of wealth westerners?

The debate on "Sustaining Livelihoods" has been slow, despite some excellent keynote contributions. Partly this may be because similar issues are being covered in another session (Economic and Development Co-operation), but I wonder if the theme "Livelihoods" has failed to capture the attention of a primarily conservation and/or biological science focused community?

I carried out a quick search on the contributions in all sessions, and found nothing on human population growth/overpopulation- that is surely a key factor in study of biodiversity's links with natural resources, agriculture, livelihoods and the rest.

Obviously, we cannot grow indefinitely. “If we are not brave enough to limit our numbers, nature will impose its own limits on our numbers and existence” (Pimentel and Pimentel, Ten Billion Mouths to Feed, http://www.popco.org/press/articles/2000-4-pimentel.html). This is nothing new. Inter alia, Ehrlich and Ehrlich said as much in the 70s, and the basic arguments stem from Malthus (if not before), and were a major influence on Darwin and Wallace. What are the solutions? It is easy to find proposed “simple solutions” (development, female education, provision of contraception etc.) but none of these can be considered a panacea (Ryerson,, “Sixteen Myths About Population”, http://www.populationmedia.org/issues/sixteen_myths/myths.html) (which is not to say they are not useful, or desirable in their own rights).

Hardin (“Tragedy of the Commons”) argued that “the freedom to breed is intolerable” - proposing the same solution, “mutual coercion mutually agreed upon”, as for other common property / open access problems. This rests partly on the idea that family size is to some extent genetically or culturally inherited, and that therefore any reliance on “moral restraint” will be ultimately self-defeating. Dawkins (“The Selfish Gene”) states “if you wish, as I do, to build a society in which individuals co-operate generously and unselfishly towards a common good, you can expect little help from biological nature”. Ryerson concludes differently: “There is broad general agreement that voluntary measures are not only preferable to coercion from an ethical and human rights standpoint, but that in the long run self-motivation will be far more effective at keeping fertility rates low than government-imposed mandates that are despised by the people”. What is the evidence on these opposing views? What are the research needs / methods?

There is another possibility, war / genocide, which some see as inevitable (Caldwell, “On Saving the Environment, and the Inevitability of Global War” http://www.foundation.bw/OnGlobalWar.htm). Though current Western sensibilities view killing as something to avoid, human history suggests that, on the whole, we're quite a violent bunch. The naked idea of killing for conservation interests may be completely beyond the bounds of current "sanctioned discourse"; we may imagine that we consider any actions resulting in the deaths of fellow humans to be utterly unacceptable and unethical. But, in general, we are quite accepting (or at least complacent, complicit and/or intellectually dishonest) in many situations in which humans die/suffer or will die/suffer as a result of our actions, consumption, or failure to act (global warming, oil exploitation/control of reserves, failure to spend on clean water provision for the developing world...).

Do we really look to conservation as a way of improving the lot of humanity as a whole? Or do we want conservation for its own sake, and/or as a support for our own consumption, or the consumption of our direct descendants? Are we then accepting of, or intellectually dishonest about, the possibility of human death and suffering in the interests of

conservation? Can we hope to delay or maybe even avoid war via conservation and other (demographic, economic, trade...) policy?

I am not advocating Social Darwinism. I do not believe that wealthy Westerners are the apex of evolution, biologically, culturally or in any other sense. But I see some form of major, violent conflict as being virtually unavoidable unless current trends change radically. Specifically, we need at least one of, and probably all of, the following: an end to rising human populations, in a form which is sustainable / not self-defeating (how?); an end to rising consumption of resources by wealthy nations (how?); a reduction in the environmental damage/demands of our livelihoods and lifestyles (how?).

This e-conference should be dealing with aspects of that last how, and the research needs it entails. Gray ("Straw Dogs") argues that there is no hope of sustainable progress, that humanism is a charade. But even if he is right, does it matter? We know human life can not last forever, so when we talk of sustainability we're not looking for true permanence. Perhaps "we have to try and make progress for the two reasons that it might actually last quite a long time, and also because there is no alternative" le Sueur, http://www.secularism.org.uk/humanletters.

Or is there? "It is not of becoming the planet's wise stewards that Earth-lovers dream, but of a time when humans have ceased to matter" (Gray, "Straw Dogs"). Is this why we don't find sustainable livelihoods an important topic?

Livelihoods, lifestyles, life on Earth

Martin Sharman, European Commission, Brussels

In his introductory statement, Dr Tinch asked us to think first about the links between livelihoods, poverty and biodiversity, and then to consider how sustainability and resilience relate to biodiversity and to livelihoods, and to identify the consequent implications for research. I am a layman and what I have to say may seem obvious to those whose profession it is to understand these things. But sometimes people who know nothing about a subject may ask some important and difficult questions. If none of my questions are important or difficult, perhaps you can help to lighten my darkness.

Biodiversity loss is almost entirely caused, directly or indirectly, by our own species. It comes about because we must eat, keep warm, and shelter from the elements, and because the richer members of our species seek ease, comfort and convenience in our daily lives. It comes about because there are so many of us, and our aggregate demand is unevenly spread over the surface of our planet, and its impact is more than many local ecosystems can bear.

What we probably have in the backs of our minds as "livelihoods" in this discussion are the primary (extractive) activities including farming, forestry, fisheries, and mining. These livelihoods often have an obvious and direct connection with biodiversity, and in many cases, with its loss. For those who work in secondary (manufacturing) activities or tertiary (service) activities, it is perhaps less the individual's livelihood than their lifestyle that has a significant impact on biodiversity.

An individual's livelihood or lifestyle is sustainable if it has no net negative impact on biodiversity over the entire period in which it is exercised. The assessment of sustainability must take into account the ecological circumstances in which it is exercised. This includes all the other people whose livelihoods and lifestyles impinge on that of the individual concerned. If there were only one butterfly collector on the planet, his hobby would make little difference to the conservation status of his prey; it is when it is shared that the hobby becomes a threat.
We probably agree that we can only survive in the long term if, on aggregate, we find honest occupations that respect other people, and have at worst a neutral, and at best a positive impact on the natural world. To find this global balance, we must each – again on aggregate – take only our fair share of the earth's resources. Fairness includes social equity, but more importantly, it must be measured in the ability of the environment to sustain our aggregated demands. If there are too many humans on the planet for this happy outcome to be feasible, then the environment will degrade, and humans either voluntarily or by ecological (and subsequent economic and social) collapse will reduce their aggregate demand. It seems to me, then, that we cannot focus only on extractive livelihoods. We are all too interlinked for that. We must also consider the lifestyles of those of us who live in cities and who earn our livings in tertiary activities.

We hear again and again that biodiversity conservation must be linked to poverty alleviation (or eradication), but whether this is for political or for scientific reasons, I am not certain. The statement that "biodiversity conservation must be linked to poverty alleviation" contains a verb that is so flaccid as to be meaningless. What, exactly, do we mean by "linked"? Do we mean that if poverty were to disappear, we would stop losing biodiversity? Certainly not. Do we mean that if biodiversity were properly conserved, poverty would go away? Again, no.

We must mean that we cannot hope either to conserve biodiversity or to alleviate poverty as activities independent of each other. What do we mean by this? Is it anything more than comforting political pablum? What, exactly, is the link between poverty and biodiversity loss? And how does it differ from the link between wealth and biodiversity loss? Does the problem for biodiversity lie with the poor of the planet, or with the rich? Yes, the rural poor in what are (sometimes euphemistically) characterised as developing countries may depend directly on, and over-harvest or over-exploit, "natural" biodiversity. The visual and biological impact of the slash-and-burn farmer's activities is undeniable. Such a livelihood cannot be sustained in our crowded planet. But it is not poor people who are fishing out the oceans.

Many authorities state (which does not necessarily make it true, but I trust these authorities!) that the ecological footprint of the industrialised nations is vastly greater than that of that of developing nations. Is it not cynical to focus on the link between biodiversity loss and the livelihoods of the rural poor while neglecting the impact of the lifestyles of the urban rich?

And what does this catchy word "footprint" really mean for biodiversity? Is the only practical definition of "significant impact on biodiversity", "net negative impact on biodiversity" or "impact on the natural world" simply "no net unwanted change in any of the indicators that we monitor"? How can we quantify our footprint? Would it not be worth something politically to be able to quantify the annual global biodiversity loss caused by someone driving, rather than cycling, to work? Or if that is too far beyond us, could we not quantify the loss of biodiversity resulting from the aggregate effect of all the lifestyles of individuals in a region or a country? Or is that, too, beyond our capacity?

And at whose door, exactly, should we lay the blame for this ecological footprint? Who is really responsible for the loss of tropical forest? Is it the multilateral agencies that have pushed countries with a large external debt to plant all those millions of hectares of oil palms? Is it me, who to satisfy my lifestyle, consumes – without necessarily realising it – all that food and those many non-food products that contain palm oil? Is it the financial institutions, or the big multi-national conglomerates whose shareholders require dividends, and whose owners need their bonuses? If we can't find someone to blame, how can we ever begin to reduce the demand on the natural world? Is it only through public opinion, ephemeral and unpredictable as it is?

The research that is indicated by these questions will perhaps involve the social scientist or the economist more than the natural scientist. But if we do not find the answer to these questions, is there any hope at all that we can change the impact on biodiversity of livelihoods (the labourer clearing the forest for the oil palm plantation) and lifestyles (the bus driver eating his deep-fried fish and chips)? And if oil palms are really too remote, what research must we do to allow the European trawler-man to find a sustainable and dignified livelihood without further damaging the biodiversity of the European fishing grounds?

Don't ask us, we're academics

Caspian Richards, Macaulay Institute, UK

Many thanks to Rob and to Martin for thought-provoking comments, or at least comments which ought to provoke thoughts. The common theme that emerged from the two in my mind was the need they identified for a collective approach to thinking about natural resources. Both emphasised very strongly the fact that it is not at the level of individuals, or even of groups, that the most pressing resource management issues emerge, but rather it is in the aggregate that the true pressures make themselves felt. I took this to mean that they need to be addressed at global level, or at least at the level of large geographical groupings. Therein lies the nub of the problem, to my mind. What scope do we currently have for debate on such issues at a global level? Those institutions set up out of a political urge to develop such an approach to world problems (e.g. the United Nations and its various programmes) are marginalised and overridden by national governments, corporations and others, but perhaps more damagingly still, divisions and oppositions between and within much smaller groupings dominate any urge to collective thought. If global political structures were to take centre stage, it is hard to see how they could ever achieve popular legitimacy in a world where any attempt to move beyond parochial units of decision-making is interpreted in many quarters as an assault on local 'identity' and 'culture'.

Various philosophers have grappled with these questions, although I think it is fair to say that none has come up with a practical answer. Immanuel Kant, at least, should be credited as one of the first to address the issue of global governance – readers will be delighted to learn that I once wrote a commentary on this aspect of his work which is freely available on-line (http://www.paideusis.matco.ro/e1n2cr.html). In one form or another, the philosophers' answer tends to depend on a sense of common humanity, whether this is available to the introspective individual, as in Kant's framework (he called it 'reason'), or is attained through collective discussion, as per Habermas. With all due respect to these great minds, it is easy to see that if everyone thinks and acts in the right way then we are more likely to get out of a collective spot, but they do not tell us what we have to do to get ourselves to think in the right way, and more importantly, to help other people to do so too. Here, perhaps, we should turn to religion, which at least in some traditions focuses precisely on helping people to think in the right way, providing exercises and pastoral support with this aim in mind. There may be other routes in, but I am not sure that we know anything much about them, except for those highly refined techniques of propaganda which are now so over-used that they have lost their impact. In general, any discovery of commonalities is hard won, and we are more often reminded of the need to respect differences (diversity, I believe it is also called) than of the need to develop common approaches.

It is ironic that Martin asks these searching questions of a predominantly academic audience, as in my experience academics are the least likely to come up with answers to this sort of thing. In the UK at least (although I believe more widely), research and teaching establishments are driven through with divisions, and are peopled by some of the most sectarian characters one is likely to encounter. The enmity between, say, a sociologist and a biochemist can be just as bitter as that between different ethnic groups, and when we get to factions within the factions, such as the myriad types of economist, we can only give thanks that they are not equipped with weapons of mass destruction. They may wield their proprietary methods like arms ('I have a method and I know how to use it!'), but at least there are no wider casualties. But in short, research groups tend to be run like private fiefdoms, their territory defended vigorously against all comers, and their students indoctrinated along the narrow lines of their own liturgy. Asking this lot to work together to address problems of universal human concern is like asking a bunch of eternally feuding warlords to quietly choose a leader amongst them.

All the same, if we are to get anywhere within our current research set-up, it is likely to be under pressure from people like Martin who persist in the face of opposition and indifference to persuade us that we can only make a valuable contribution if we apply our

fragmented insights in a combined way in order to address the really big questions. Making progress is bound to require a carrot and stick approach, using funding as a means of bringing academics together against their natural inclinations. People being people, there is some hope that once they actually get to know each other then some of them will discover common ground they never suspected that they had. But above all, my advice would be to get them while they're young, and push on with initiatives like summer schools, which combine different approaches from an early stage in research careers.

Finally, I particularly appreciated Martin's tirade against the indiscriminate use of the word 'linked', which very much struck a chord with me, as I have often asked in vain what real connection was being alluded to when told that such and such a project was 'linked' to another, or that there were 'links' between two people's work. It highlights the fact that if he and others want us to work together properly, then they'll have to watch us like hawks, as we'll forever be trying to tick the boxes without addressing the underlying concerns. Be very wary of the word – it generally means that one wants to put two different concepts in the same sentence but hasn't the faintest idea how to justify doing so.

Biodiversity, tourism and livelihoods: Key research questions in the context of climate change

Murray Simpson, School of Geography and the Environment, Oxford University

SUMMARY: Tourism is one of the largest industries in the world and affects the livelihoods of millions of people worldwide. Biodiversity underpins a large proportion of the industry and provides 'Unique Selling Points' to hundreds of thousands of destinations. Changes in biodiversity as a result of climate change will greatly affect the supply of product to the tourism industry, tourists' demand, and the livelihoods of those communities that are reliant on the sustainability of tourism. Research is urgently required to understand and evaluate the existing and potential impacts of climate change on the terrestrial and marine biodiversity on which tourism depends in order to devise appropriate strategies for capacity building and sustaining livelihoods.

In 2006 the travel and tourism industry will confirm its position as the world's largest employer with over 11% of the globe's employees and the world's largest industry with gross output of over US$7 trillion and GDP of 11.5% (World Travel and Tourism Council 2003). The World Tourism Organization (WTO) estimates that by 2020 there will be 1.6 billion international travellers, the livelihood impacts of this vast industry are already varied and far-reaching are set to become even more acute.

The Industry and Environment Office of the United Nations Environment Programme (UNEP/IE) stated in its Global Biodiversity Assessment Report in 1995 that the environment is the most essential resource for the growth of tourism; "Tourism is extremely sensitive to the environment and should negative environmental effects diminish the tourism experience, tourism growth and sustainability are seriously jeopardised." Tourists are reaching more remote and fragile places and visitation to existing high volume sites is increasing dramatically, the potential impacts on the world's biodiversity and natural and cultural heritage are equally dramatic. Tourism has been recognised as potentially delivering net benefits to the environments affected by increased visitation and to communities living within and adjacent to destinations through the diversification of economic opportunities for local people, contributions to poverty alleviation and the enhancement of both rural and urban livelihoods.

Climate change has added an important and complex variable to the delicate balance of factors contributing to the positive and negative impacts of tourism on destinations, biodiversity and communities around the world. There will be significant differentiation in the extent of the variable's importance and its impacts depending on geographic location. The impacts of climate change on tourism, its stakeholders, adjacent communities and related industries at both a macro and a micro level cannot be understated, the key impacts fall into two broad categories: 1) Increased frequency and magnitude of extreme events, including; flash floods, hurricanes/tornados/cyclones, drought, fire and storm surge and; 2) Cumulative changes, including; ground and air temperature changes, sea level rise, sea temperature increase, retrieving glaciers, desertification, water salinisation, silting and degradation, increased wave height, fluctuation of precipitation levels and loss of seasonal distinctions (Intergovernmental Panel on Climate Change 2001).

The resulting impacts on biodiversity affecting tourism and livelihoods include: coastline degradation, changing habitats, flooding, heightened water resource management issues, species degradation, coral bleaching, reductions in wildlife abundance and forestry degradation. In addition other factors resulting from climate change that will impact on tourism and livelihoods include: changes in visitation flows, a decline in public health and safety and an increase in disease, water quality vulnerability, threats to coastal infrastructure, increased poverty, unstable food security and an insecure agricultural sector, dangers in river access, threats to hydroelectric power generation, threats to natural and cultural heritage assets, pressure on services as a result of increased visitation and threatened/unstable physical infrastructure including buildings, roads and communications.

Pragmatic research is urgently required into the interactions of climate change, biodiversity, tourism and livelihoods including the evaluation of existing and potential impacts from both a macro and a micro destinational perspective. Consideration of potential adaptation and mitigation strategies should play a significant role in the research and not only take account of industry, tourist, government and secondary industry perspectives but also include serious consideration of the factors that impact on poverty and the sustainable livelihoods of communities. Regions that require urgent study include; the Mediterranean Basin, Small Island States, Northern Europe, Developing Countries and New EU Member States.

RE: Biodiversity, tourism and livelihoods: Key research questions in the context of climate change

Adriana Vella, Department of Biology, University of Malta, Malta

The overview given by Murray Simpson is interesting and poses challenging research requirements that need to be addressed urgently. Islands in the Mediterranean can be taken as examples to illustrate how acute the impacts of increasing tourism, low environmental awareness and climate change are becoming. Sustainable tourism and eco tourism need to be encouraged while making sure that the proper conservation research and monitoring structures are in place to assist effective management and implementation of sustainable or eco tourism. Also more demanding will be predicting the impacts of climate change on island biodiversity, habitats and vulnerability of these to tourism pressures.

RE: Biodiversity, tourism and livelihoods - Mediterranean islands as a model for studies of sustaining livelihood and biodiversity?

Klaus Henle , UFZ Leipzig-Halle, Germany

Murray Simpson argues that synergistic and adverse interrelationships between tourism and biodiversity are a major challenge and Adriana Vella points out that Mediterranean islands are a suitable model to address these challenges. Below I argue that islands (and especially Mediterranean islands) are suitable models to study the effects of land use change for sustaining livelihood and biodiversity.

The biodiversity of islands is particularly sensitive to changes in land use, and no other ecosystem is as vulnerable to invasions by alien species, including humans, as islands. Mediterranean islands are no exception. In particular, since early Neolithic times, human settlers have heavily impacted on these vulnerable ecosystems. Changes in land use patterns and the introduction of a variety of alien species caused radical changes in natural habitats and a sharp turnover between ancient and modern Mediterranean insular faunas and floras (e.g. Reese 1996, Alcover et al. 1999). Mediterranean islands are characterized by different histories of land use but similar socio-economic transitions and thus provide particularly good models for a study of the effects of a transition from agricultural/fishery mode of sustaining livelihood to a tourism based livelihood. In spite of a long-established knowledge that invasive species, land use change, and intrinsic factors can have devastating and cascading effects on island ecosystems, the reasons for striking differences in impacts among island systems, e.g. the Western, Central, and Eastern Mediterranean Sea, remain to be elucidated. Most existing comparative studies have limited geographic range, address single taxonomic groups (Preiss et al. 1997), and generally use different methods that render comparative analyses difficult. Therefore, a methodology that allows a standardised assessment of the vulnerability of island ecosystems and a better understanding and prediction of changes in island biodiversity at different levels of human interference are of paramount importance in the development of global conservation strategies.

Haraz agro-forestry system

Abdel Nour Hassan, FAO Regional Office for Near-east, Cairo, Egypt

Various communities in the Gum Arabic Belt in Sub-Saharan Africa have developed a number of agro-forestry and agro-sylvopastoral systems. The most pronounced is perhaps the one that uses haraz (*Faidherbia albida*). Haraz is a tree that can attain enormous size such as in the foothills of Jebel Marra in Darfur -Sudan. The tree sheds its leaves during the rainy season (July-October) thus allowing light over the entire crown projection area right to the bole.

Having known the tree phenology over the centuries, communities in Darfur thorn fence and crop the entire area under haraz with both staple (sorghum and millet) and cash crops (tomato, chilli, etc). During winter and summer (November to June) the tree produces its leaves and pods, casting a heavy shade. Livestock, particularly sheep and goats use the tree for crop residues, shade and nutritious pods. In doing so they add animal manure to further fertilize an already ameliorated soil rendered so by the nitrogen fixed by the haraz root system and decomposition of twigs and leafs.

Haraz usually grows along seasonal watercourses with shallow water table. In such places, the system includes supplementary irrigation from hand-dug wells where water is manually drawn with buckets and ropes or through draught animals.

When felled during the course of management (thinning operations or when the tree is wind thrown following root collar zone rot), the wood is used for a multitude of uses including carpentry, joinery and hand hewing of wooden utensils such as mortars, oil mills and shoe lasts.

The system is practiced as a family concern where the husband, wife and other members contribute to the labour requirements. The role of the tree in sustainable livelihoods can thus hardly be overstressed.

A lot of myth still surrounds *Faidherbia albida*, particularly the phenomenon of shedding leaves during the rainy season; commonly referred to in Sudan as a “belligerency towards rains”. Many aspects of the tree management such as regeneration, growths etc also need to be elaborated through research.

Research needs for sustaining livelihoods: Opening statement to session 3

Rob Tinch, Session chair, Macaulay Institute, UK

SUMMARY: In the sustainable livelihoods and biodiversity e-conference, we have enjoyed some wide-ranging contributions with some general implications for the research agenda and the ethical principles to which research must conform. In the last week of the conference, we hope to see more discussion and some more direct proposals for specific areas which urgently require attention in the light of the 2010 targets.

Kicking off the conference, John Cameron defined development as "what people value as improvement in the human condition", and stresses the local specificity of this concept. He set this in the context of ethics, arguing that this implies the need for a precautionary approach (in policy and in research) and the need for "full public deliberation" as a requirement for legitimate policy making / use of research. These concepts were picked up by other contributors to the session:

Rosie Cooney expanded on the precautionary principle, showing areas in which its correct application is not obvious, and deriving key research questions

1) Does conservation policy adequately recognise and deal with uncertainty?
2) Can the precautionary principle lead to negative impact on livelihoods?
3) How can we use the PP to benefit both biodiversity and livelihoods?

Martin Sharman flagged up the important connection between "livelihood" and "lifestyle"; although "livelihoods" is often used in a particular way within a particular discipline, similar issues arise with both concepts. Dr Sharman stressed equity issues, and the unfairness of focusing on the relatively minor "ecological footprints" of individuals in the developing world, compared with those of rich western consumers, even though the developing world footprints may be more immediately, locally apparent, and/or may when summed together over whole populations amount to significant impacts. He stressed the basic question "how can we ever begin to reduce the demand on the natural world?"

Jorgen Thomsen focused on the importance of participation as a requirement for legitimacy. He stressed basic natural and social science research which needs to be done, but must be done in a participatory way.

Caspian Richards made a strong case for interdisciplinarity and openness in our research, as an indispensable but incomplete response to the problem of achieving legitimacy in addressing global problems such as biodiversity loss.

Murray Simpson pointed out the crucial importance of the travel and tourism industry, both for the global economy and in terms of biodiversity impacts, and the interactions with climate change. He points out the potential for tourism to enhance opportunities and livelihoods for local populations, and also the risks associated with inappropriate or excessive tourism. He stressed the need for a wide range of fundamental research in this field, in particular considering adaptation and mitigation strategies.

In the remainder of this conference, we hope to have four or five more keynote presentations (some of them are a little late, hence the uncertainty!). I invite you all to reflect in particular on the research needs arising out of these contributions; by which I mean general research issues and general principles to which research should conform (as we have already discussed in the last two weeks) but also any specific ideas for particular research projects or more narrowly defined topics.

Research needs for a framework for sustainable livelihoods, biodiversity conservation and conflict resolution: 'Let's be a bit introspective about this conflicts business'

Caspian Richards, Macaulay Institute, UK

SUMMARY: Research on conflicts between biodiversity conservation and livelihoods needs to be backed up by an awareness of the role often played by academic conflicts in creating or exacerbating them, and by a recognition that conflict resolution approaches are also needed if we are to deal with long-standing and destructive conflicts within our own profession.

If there is a positive consequence of the fact that conflicts between biodiversity conservation and livelihoods are increasing (to judge by the growing number of sightings of them), it is that the themes of conflict management and stakeholder participation are now being given serious academic consideration. This is not to imply that academic consideration will help to resolve such conflicts – on previous form there is reason to fear the opposite – but rather that academics are thereby brought into contact with practitioners skilled in bringing together and reconciling people with different perspectives. Perhaps the main benefit of academic interest in the practice of conflict management is the prospect that we may become better able to address long-standing conflicts within our own profession, some of which have played a part in creating or exacerbating conflicts between biodiversity conservation and livelihoods in the wider world.

If we as academics are able to frame so many conflicts in terms of the supposed opposites of biodiversity conservation and livelihoods, it is because academic research consists of two distinct types of people: people who study nature (biodiversity), and people who study people (livelihoods). Despite the fact that many outside the academies – particularly those whose work or play involves practical engagement with the world of living things – do not find this separation between 'people' and 'nature' intelligible, there are many respects in which it has been imposed upon them. Researchers working on biodiversity conservation have often returned to tell us that people all over the world are messing up nature, prompting conservation NGOs and sometimes governments to go and sort them out. Researchers studying the people in question return to tell us of the human tragedies that have sometimes resulted (in the absence of overt tragedies, they often hunt for at least some measure of local discontent with which to accuse the natural scientists), propagating our own turf wars as to whether 'people' or 'nature' are more important.

One pressing research priority is therefore that researchers draw on their increased exposure to the practical skills of conflict resolution in order to address conflicts within the research profession itself. It is encouraging that there is growing support for interdisciplinary work from the EC, with some early indications that national research backers are beginning to follow suit. However, this needs to be backed up by careful monitoring to ensure that projects calling themselves interdisciplinary are genuinely succeeding in building bridges, rather than serving to fan the flames by bringing our own disagreements into the mix of any conflicts being studied. Judging from projects I have been involved in, there is a will among participants to attempt to overcome the barriers splitting social from natural sciences, but it is also clear that any mutual understanding will take considerable time. A focus on the study of conflict resolution provides one means of getting the two groups together, with the added benefit of working with practitioners who can teach the personal skills we need in order to address the differences among ourselves.

In sum, while it is undoubtedly easier to study and attempt to resolve conflicts elsewhere in the world in which we are not personally implicated, ultimately we need to find the courage to deal with those at home, which means recognising how our own actions contribute to prolonging and spreading them. The same applies in the case of participatory approaches, where many of us work in organisations that are anything but participatory, and yet we are all too happy to advise others on how to set their house in order.

Poverty and biodiversity: Moving beyond prevalent assumptions

Marina Michaelidou, Unit of Environmental Studies, Intercollege, Cyprus

SUMMARY: Nature conservation policies are based on the assumption that poor communities pose a threat to biodiversity. Even though little evidence exists to support these assumptions, they have persisted in international conservation efforts. It is important to recognize and re-evaluate these assumptions because they are harming the conservation of biological diversity.

Nature conservation policies are often based on the assumption that poor communities lack an appreciation for nature and pose a threat to biodiversity. Despite evidence that casts doubt on the link between poverty and the loss of biological diversity (Duraiappah, 1998; Michaelidou and Decker 2003), the assumption that poor people are an impediment to biodiversity conservation has persisted in the international conservation arena.

In what has been called the 'fences and fines' conservation method, local people are driven out of areas designated for protection, in exchange for some form of compensation (Neumann, 1997). Conservationists who support this approach believe that "People of all stripes, whether indigenous or not, pose a grave threat to the biological integrity of any park when they must derive their livelihoods from the park's natural resources" (Terborgh and Peres, 2002, p. 307).

The implementation of integrated conservation and development projects (ICDPs) is a different conservation approach, which aims at combining biodiversity conservation with community development and poverty alleviation. Although ICDPs are an improvement over the 'fences and fines' method because they take the economic needs of local communities into consideration, they are also based on the assumption that local practices are threatening to biodiversity conservation and focus on "providing local people with alternative sources of income that do not threaten to deplete the flora and fauna of the parks" (Brandon, 1997, p. 93). Alternative occupations, such as ecotourism, are sometimes implemented in a top-down way, with little consideration for the cultural importance of certain local practices (Neumann, 1997; Michaelidou et al., 2002).

The assumption that poor communities lack a conservation ethic and are responsible for the loss of biodiversity is also more generally directed towards less developed countries (Michaelidou and Decker, 2003). In a book titled Environmental Policy in the European Union: Actors, Institutions and Processes, Pridham (2002, p. 95) argues that in "central and northern Europe, environmental values are generally more developed." This perspective is used to justify the centralization of nature conservation in many situations. Terborgh and Boza, for example, argue that "responsibility for rescuing nature must fall on the so-called 'international community,' consisting largely of the major industrialised nations" (2002, p. 384). Such attitudes only help to create antagonism between conservation institutions and local communities in less developed countries and fail to create a ground for true partnership and collaboration.

The participation of local communities in biodiversity research and biodiversity conservation is essential for eliminating false assumptions about the relationship between local people and nature and for implementing policies that better address people's needs. Furthermore, instead of focusing on changing the practices of poor communities and on 'educating' and 'sensitizing' them for why conservation is necessary, it is important to address the issue of over-consumption, which leads to the degradation of natural ecosystems and to the loss of biodiversity. As Martin Sharman argues in his contribution "Livelihoods, lifestyles, life on Earth," it is time to move beyond the link between poverty and biodiversity loss and begin examining the link between wealth and biodiversity loss. It is also time to recognize the set of assumptions that are driving many conservation policies and re-evaluate them because they are harming the conservation of biological diversity.

Conservation Research and Natural Capital

Adriana Vella, Department of Biology, University of Malta, Malta

Conservation Research as a multi-disciplinary subject/activity that has developed in response to the needs of reducing biodiversity loss, and later sustainable development is indeed a research area that should not be ignored in our quest to focus on required future research directions. Perhaps one may point to two main points using contributions by various workers in this field. Statements such as "Sustainable management of living natural resources demands that the biological and ecological information is combined with profound knowledge of local socio-economic and cultural structures. The slogan think globally; act locally illustrates pointedly the guideline for actions to safeguard Earth's genetic resources for the future." by Sandlund, Hinder and Brown 1992 in Conservation of Biodiversity for Sustainable Development. The stress on local versus global is essential if the human resource, which is certainly on the increase, is to be utilised to improve current environmental degradation and impoverishment. Locals need to be encouraged to understand how their own actions have changed their own surroundings and affected the natural resources their lives depend upon. Here local biological conservation research and socio-economic considerations would be vital to obtain this accurate local knowledge for improved awareness, education and management plans.

At the same time however, we need to recognize the role played by the economy at both local and international levels. Here one may use statements by Hawkens and Prugh 1995 in Natural Capital and Human Economic Survival, where "In biological terms, humanity has succeeded to a fault. Like no other species, we claim virtually the entire Earth as our habitat. By learning to use nature ingeniously, we have invented ways of living that allow us to imagine ourselves free of it... One important reason for this is our economic system that apparently tells us that it is cheaper to destroy Earth than to maintain it. ..An economic system that has no way of valuing the cost of a 700-year-old tree, our beleaguered air, our threatened watersheds, our overworked soils and the breakdown of stability due to the increasing conflicts based on resource shortage." Here one may add that our economies equally lack considerations of the costs for the regenerations of over-exploited seas, impoverished ecosystems which have lost numerous species living gaps that are not always easily replaced by other species, degraded raw materials such as water, air and land that may increasingly affect human health.

Recognizing the value of natural resources that sustain our lives on Earth is fundamental. This recognition will need to be enlightened by accurate knowledge of the biology of the species around us or biodiversity and how these indeed become vulnerable to human impacts. This information needs to be absorbed in a new economic system that utilises such accurate knowledge or precautionary attitude (until the former is available) to put a cost to natural resources used directly or indirectly by mankind. Difficult a task as it may seem, this ecosystem and natural resources based economics is picking up some ground but will need to come further down to the everyday and local economic running of every nation. An essential point here is the need for this effort to be global so as not to disadvantage nations that start to integrate natural resources and biodiversity values in their accounts, as opposed to those that continue to rate them at cost zero.

Research toward our biodiversity, species' biological needs and vulnerabilities to understand the measures required for conserving them, needs to develop hand in hand with research in ways to update our economic systems to respect current urgent needs, limiting resources and our natural capital. Research on how human resources may be utilised to the full in future generations toward sustaining livelihoods is another important area.

Research priorities so far identified for biodiversity and sustainable livelihoods

Rob Tinch, Session chair, Macaulay Institute, UK

Underlying ecological knowledge: To foster greater understanding of the relationship between conservation and sustaining livelihoods, we must increase our knowledge of the processes that enable healthy ecosystems to provide broad-scale ecological services and of the economic value of those services to nations and their citizens.

- Identifying the core ecological processes supporting ecosystem services
- Understanding the effect of change on these processes

Integration with economic systems: Basic ecological research in biodiversity and conservation needs to develop hand in hand with research in ways to update our economic systems to respect current urgent needs, limiting resources and our natural capital. Research on how human resources may be utilised to the full in future generations toward sustaining livelihoods is another important area.

Research is needed to define economic valuation techniques for assessing the monetary value of ecosystem services (or more generally, into improved ways of taking biodiversity values into account in decision making processes).

Ethics and apportioning "blame": It is time to move beyond the link between poverty and biodiversity loss and begin examining the link between wealth and biodiversity loss. It is also time to recognize the set of assumptions that are driving many conservation policies and re-evaluate them because they are harming the conservation of biological diversity.

How can we quantify our footprint? Could we quantify the annual global biodiversity loss caused by someone driving, rather than cycling, to work? Or could we quantify the loss of biodiversity resulting from the aggregate effect of all the lifestyles of individuals in a region or a country? At whose door should we lay the blame for this ecological footprint?

Precaution, dealing with risk: Does biodiversity conservation policy adequately recognise and deal with scientific uncertainty and risk? Can implementation of the precautionary principle have negative livelihood consequences? How can the precautionary principle be operationalised to both further biodiversity conservation and support sustainable livelihoods?

Climate change, biodiversity and livelihoods: Research is urgently required to understand and evaluate the existing and potential impacts of climate change on the terrestrial and marine biodiversity on which tourism depends in order to devise appropriate strategies for capacity building and sustaining livelihoods. Consideration of potential adaptation and mitigation strategies should play a significant role in the research and not only take account of industry, tourist, government and secondary industry perspectives but also include serious consideration of the factors that impact on poverty and the sustainable livelihoods of communities. Regions that require urgent study include; the Mediterranean Basin, Small Island States, Northern Europe, Developing Countries and New EU Member States.

Specific projects: Haraz (Faidherbia albida) is a tree that can attain enormous size such as in the foothills of Jebel Marra in Darfur -Sudan. Many aspects of the tree management such as regeneration, growth etc also need to be elaborated through research.

Islands (and especially Mediterranean islands) are suitable models to study the effects of land use change for sustaining livelihood and biodiversity. A methodology that allows a standardised assessment of the vulnerability of island ecosystems and a better understanding and prediction of changes in island biodiversity at different levels of human interference are of paramount importance in the development of global conservation strategies.

Research methods: One pressing research priority is that researchers draw on their increased exposure to the practical skills of conflict resolution in order to address conflicts within the research profession itself.

What is missing from the above list? Do the comments under "ethics" adequately reflect research needs in conflict resolution and improvement of participatory approaches to research and management? Is there more to be said from the perspective of disciplines other than ecology and economics?

RE: Research priorities so far identified for biodiversity and sustainable livelihoods

David Coates, U N E P - S C B D (Secretariat - Convention on Biological Diversity), Montreal, Canada

The debate needs to be simplified.

Ref. "Livelihoods" - there are possibly (for the sake of debate) two main categories of people who are dependent - First those who depend upon biodiversity directly (livelihoods dependency - especially related to food and nutrition) - these are abundant in developing countries - e.g. poor people in rural areas who depend directly upon ecosystem goods and services (e.g., fisheries, non-timber forest resources, etc), the "biodiversity vulnerable". Second, those who depend less directly upon biodiversity for day-to-day existence (most people in the developed world). For the latter group "biodiversity" is not widely recognised (by them) as essential for daily life - and its conservation (in livelihoods terms) a difficult case to argue. For the former - it represents daily sustenance and survival - the case for better management is clear. It is the former group that we need to focus on - because they are generally the poor. There are admittedly all shades of grey in between.

Attempting to assess the benefits of biodiversity in "monetary" values is not a sensible approach (although it can be useful). This forces the debate into formal economics - which has serious limits for applying fair and equitable analysis to biodiversity values (although it has a role to play). The whole point of "livelihoods" based approaches is that the values of goods and services, and various forms of capital, can be expressed in many ways - and financial (monetary) values are often not the most important or relevant. Livelihoods framework analysis (identifying various forms of capital, vulnerability, risks and responses to stress) is much better at assessing biodiversity values for poor people - especially the rural poor.

Research on "livelihoods" should focus on livelihoods based research (i.e., socio-economic) - not ecology based. It is because of the bias towards biology/ecology-based approaches that we are unable to adequately address biodiversity values and to develop a policy framework that is responsive to human development goals. The fact that we know so much about ecosystems and species, but so little about how the changes in them affect people - is a sad reflection on our approach to biodiversity conservation.

This debate should shift to how biodiversity and its management can support the achievement of the Millennium Development Goals - and in particular the reduction of global poverty.

Livelihoods

Lars Bjork, Ethnobotany, Uppsala University

We also have poor people within EU and Europe for which collection of threatened species plays a role in their village pharmacy and for collection for income, i.e. in Romania, Bulgaria, Macedonia, Albania.

The area exports large amounts of medicinal plants, (25 – 40.000 tons of dried plants per year) which are also the basis for the village "pharmacies". Most of the materials are wild collected plants and several species are now threatened through over-collection. Most of the collectors are elderly women with poor economy. Shortage of plants results in a more tedious collection, new areas for collection and possible conflicts between collectors from different ethnic groups due to trying to get the last individuals from the same area.

Solutions: Research that defines threatened species in the area; Selection of genotypes with high accumulation of active compounds; Propagation of selected genotypes; Domestication of propagated material; Training in horticultural production of selected species by former collectors; Organizing co-operative post harvest treatment.

Research work should be performed in cooperation with individuals from the different ethnic groups. A small program has already started by Professor Estatieva at the Bulgarian Academy of Science.

RE: Research priorities so far identified for biodiversity and sustainable livelihoods

Rob Tinch, Session chair, Macaulay Institute, UK

SUMMARY: David Coates' contribution flags up a basic tension between the development and biodiversity communities, and in particular over the use of the term "livelihoods".

"It is the former group that we need to focus on - because they are generally the poor": Why should we focus on the poor? Isn't 90% of the problem that the rich consume too much of our resources? (see Martin Sharman's contribution, and below).

"Research on "livelihoods" should focus on livelihoods based research (i.e. socio-economic) - not ecology based": I think one objective is to discover what biodiversity / ecology science research is required to support livelihoods research and policy. No exclusively socio-economic approach can help us, just as no exclusively natural science approach can - we must engage in interdisciplinary research and policy support.

"The fact that we know so much about ecosystems and species, but so little about how the changes in them affect people - is a sad reflection on our approach to biodiversity conservation": Is this true? I'd say there are big gaps in knowledge all round, but that we do know quite a bit about how people and ecosystems interact. We may be managing resources quite inappropriately overall, but I don't think that's really due to lack of scientific understanding, though better integration of knowledge across disciplines could certainly help.

"This debate should shift to how biodiversity and its management can support the achievement of the Millennium Development Goals - and in particular the reduction of global poverty": Why? If we really wanted to reduce global poverty, couldn't we find much easier ways to do it than via conservation policy? For me the real challenge is how to make sure that human exploitation of the world remains within sustainable limits - so how can we make sure that livelihoods enhance biodiversity, rather than the other way round. To achieve this, we need to address our rich, Western livelihoods and lifestyles - though I accept that this isn't the sense in which the term "livelihoods" is used by the development studies community.

Of course we need to use biodiversity science to support livelihoods analysis in the development studies sense, combining our understanding of ecological systems, human-environment interactions and existing management systems. And it is important to enhance and support livelihoods in developing countries, and to be wary of applying "one size fits all" western imperialist/market-based solutions where they may be unwelcome or inappropriate.

But the fundamental point remains that it is we who are primarily responsible for environmental destruction, directly or indirectly, and too narrow a focus on the livelihoods of the poor risks being an exercise in self-delusion / passing the buck.

RE: Research priorities so far identified for biodiversity and sustainable livelihoods

David Coates, U N E P - S C B D (Secretariat - Convention on Biological Diversity), Montreal, Canada

I mostly agree with Rob Tinch's points - and especially that over-consumption by "rich" people is the larger problem.

But I see little evidence of a change in human nature in this respect- and this is not a research issue but a social/political one. We already know we consume too much. The fact of the matter is that even given (unlikely) major shifts in human nature (e.g., reductions in per

capita consumption in rich countries) we are still going to have major environmental changes (in particular climate change) and a major loss of biodiversity (due to population growth and developing economies- neither of which can or should be stopped). This is inevitable. Naturally we should be trying to reduce the change as much as possible. But we should be pragmatic and note that our task is to manage change and not to stop it. In the process of change there will be "winners" (economically) and losers. The losers will most likely be the poor. I think the poor are more important than the rich. We therefore need to know how to manage the changes so that they impact the poor the least (or that the benefits of change help them the most). Understanding how biodiversity supports livelihoods of the poor is an important part of this. Although Rob perhaps has a point that maybe we do know a lot about livelihoods etc. (or more than we think)- the problem is then achieving policy responses that take account of this. This would point to the need for more policy/governance analysis and research (not ecological/livelihoods research).

The latter point is well worth amplifying. As scientists we often think that the solution to problems is scientific knowledge. But time after time we are provided convincing evidence that this is not the case. Yet we continue to provide the same old information. Perhaps it would help if we understood better how policies were generated and implemented and the governance structures that go along with them. We should ask "what activities/ information will influence policies (improve governance)" instead of deciding ourselves what we think is needed. We also need to look at how to maintain the ability of ecosystems (and societies/communities) to respond to the changes that are happening. This is important because the ecosystems will have to do this on their own. We can't do it for them. The Millennium Development Goals are important because they state what most of our governments (who are in charge) have agreed that we shall all try and achieve.

Effective policy for sustainable livelihoods

Kajetan Perzanowski, Carpathian Wildlife Research Station, Poland

As a comment to contributions of Rob Tinch and David Coates I would like to point out that it is equally necessary to find out an effective policy to approach both groups "rich" and "poor", however for different reasons. The "rich", as Rob Tinch has mentioned, are responsible for the largest consumption of energy and resources, however the "poor" as it can be seen in Africa, India, or South America, driven by a need for survival - are able to strip the land to the bare rock. On the other hand, the "rich" are decision makers, so if we consider as necessary changes in e.g. the legislation, it is unavoidable to convince the "rich" that such changes are beneficial for their future welfare, economic profits etc. This is a job for socio-economists, however ecologists should provide them with tools i.e. effective methods to manage natural resources (both the sustainable use and restoration). The other related aspect that should become the focus of ecological research is how to estimate the capacity of a given ecosystem for human-related disturbance.

Livelihoods & interdisciplinary enquiry

Joanna Birch, Department of Geography/School of Education, University of Durham, UK

One of the key points arising from the interesting livelihoods discussions so far is that we are often still thinking in dualisms for example: rich and poor; science and politics; biodiversity versus livelihoods or global versus local. Even in the ways we are thinking, we argue about or may be we rightfully consider the merits of quantifying versus engaging in sociological enquiry.

Our understandings are still bound within separate areas and as research communities, we are still cautious about mixing up our segmented thinking. That is of course because mixing it up is difficult.

Rob Tinch made the point earlier that “no exclusively socio-economic approach can help us, just as no exclusively natural science approach can - we must engage in interdisciplinary research and policy support”. This absolutely makes sense, just as dealing exclusively with rich or poor or any of the other 'halves' without the other is ultimately only going to give us half a picture.

Certainly, distinctive livelihoods studies such as Lars Bjork's interesting example of village pharmacies are worthwhile; the example helps to illustrate that we can learn by exploring particular levels and facets of livelihoods such as social and biodiversity conflicts at village level and among ethnic groups. In our study - Integrated Management of European Wetlands (IMEW, a 5th framework EU project directed by Sandra Bell at Durham), we too are finding that the livelihoods of people in the Danube Delta are sometimes connected to local and international sale of medicinal plants, leeches and frogs.

I'd like to share here just three snapshots of IMEW to demonstrate that current enquiry IS addressing some of the research issues and questions mentioned by Adriana Vella, Rob Tinch and David Coates and which attempts to mix up the usual lines of enquiry in a interdisciplinary fashion:

- We are engaged in a work package that involves livelihoods study conducted with people from a variety of communities in Finnish, Greek, Lithuanian and Romanian wetland locations. Whilst another work package seeks to understand in new depth “realities” about the ecosystems and species that David Coates suggests we know much about (we often don't know as much about the local level as we think we do), the livelihoods element really does aim to reveal more about how the changes in them affect people. Yes, we know a something about how people interact with their natural resources, but certainly not enough. In our case, we are interested in knowing more about exactly how dependent local wetland inhabitants are upon natural resources - directly or indirectly. It is a worthwhile finding that even though some of the 'richest' people in our study seem to have jobs quite disconnected from the environment on first look, they talk about their livelihoods expressing the essential nature of cultural capital, for example their rights to collect mushrooms or berries or fish to feed their families. How people perceive their own livelihoods is important because livelihoods thinking does concern well being and alternative forms of income that supplement the more obvious financial incomes. A combination of ecosystems science with social science here has indicated to us, for example, that people’s livelihoods in the Saimaa Lakes are not so much impacted upon by seals eating significant quantities of commercial fish which might otherwise be an economic asset to local people but that cultural capital and rights to resources are significant aspects of people’s livelihoods which may in turn affect their reactions to biodiversity issues such as seal conservation.

- Biodiversity science can support livelihoods analysis and vice versa, as Rob Tinch hopes. In our livelihoods study, we are considering how people's livelihoods are connected with how they are or are not gaining environmental endowments (e.g. theoretical rights to natural resources), entitlements (access to natural resources) and capabilities (what people can actually do with their natural resources)(Leach, Mearns and Scoones 1997). We want to consider whether people's livelihoods in wetlands (and the multiple factors that affect them) are somehow obstructing people from making economic and/or sustainable use of natural resources. We find that the biodiversity science - such as evidence of the literal reduction in fish species because of water level fluctuation in Kerkini Lake in Greece - is an essential aspect of our livelihoods enquiry. Simultaneously, social, political and economic institutions affect livelihoods which then impact upon biodiversity directly and hopefully our ideas about applying biodiversity science to policy. For livelihoods to enhance biodiversity, both scientific and social understandings should be reached concurrently...about the same issues and in the same locations...we see time and time again that generalisations from global to local are not always appropriate.

- Adriana Vella calls for biological and ecological information to be combined with profound knowledge of local socio-economic and cultural structures. I agree absolutely. IMEW’s livelihood studies, coupled with other work packages seeking to understand institutional governance at different levels; to explore attitudes and knowledge and education

of local adults and children concerning their wetland environments and to explore the foundations of wildlife-people conflicts within scientific data are a definite attempt to realise this combination in research. Local people's connections or "disconnections" between global biodiversity issues and local use of natural resources might be better understood with more research that combines more enquiry into political, cultural, institutional and educational settings within communities and we are endeavouring to do this.

These points are not singing the praises of one of many projects going on. It may seem that this message is more of the same banging on about the need for interdisciplinary research. And in a way it is.

Livelihoods based approaches

David Coates, U N E P - S C B D (Secretariat - Convention on Biological Diversity), Montreal, Canada

What is "Biodiversity Science"? In any impartial context this should include livelihoods based (scientific) approaches to biodiversity management. Biodiversity science cannot therefore contribute to livelihoods approaches. They are part of the same thing. Aren't they? This was entirely my earlier point. And since when has "science" been different to "social" approaches (don't we refer to the latter as "social sciences"?). A more important recent point I made was why does the research we do and the information we gather not lead to appropriate policies and management. This is the key question.

I am fully supportive of livelihoods based approaches. They work very well indeed for wetland related functions, goods and services (particularly in the tropics). But I have personally experienced outright rejection of livelihoods based approaches quite simply because they are more accurate and air than the more formal economic analyses. Many policy makers do not want accurate information because it interferes with pre-determined plans and personal agendas. This is one reason we do not know enough about biodiversity, poverty and sustainable development - because often people in positions of authority simply do not want to know - and when the information is provided it is buried. That is a problem we need to research.

On this point: Can people please provide good case studies showing that the production of good livelihoods based information and analyses has led to actual practical real and significant changes in governance, policy and management approaches. I'm particularly interested in any wetland (including rivers/lakes) examples with a biodiversity/ environment/ poverty link. I don't need examples of studies showing what should be done. I need examples of how things have been improved. Apart from the interests of the current debate, I would like to use more examples in my professional work. Any offers?

RE: Livelihoods based approaches

Per Sjögren-Gulve, Department of Conservation Biology and Genetics, Uppsala University, Sweden

I fully agree with Rob Tinch's comments on David Coates' contribution. At the same time, I feel that the work with biodiversity conservation and sustainable development in Europe in light of the CBD also will have positive global effects, for example, regarding poverty.

Research and livelihoods

Francisco Pugnaire, Spanish National Council of Scientific Research, Spain

Although Europe's conservation problems could be considered minor in comparison with those of other world regions, the target of halting biodiversity loss in Europe by 2010 is a necessary and welcomed effort, which may indirectly contribute to conserving biodiversity elsewhere. Particularly if the research "needs" identified in this conference are satisfied. In my view, these needs go far beyond current requirements to preserve European biodiversity: they constitute a complete work program which would keep several generations of scientists busy, even if all funding resources for IP and NoE were assigned to biodiversity research in future years. Strong political action to change the attitudes and livelihoods of European citizens might be more pressing than research, and it might be worthwhile to invest some money in pushing EU and national politicians to act in this direction.

For example, in Spain, the Iberian lynx is seriously threatened with extinction, and massive amounts of money are allocated to conservation measures. The movement of almost every cat is now monitored by the government, environmental managers, scientists, NGOs, and the media. The knowledge we gather from such research is doing little to keep Iberian lynxes alive: construction works keep on going around their habitat, increasing fragmentation and compromising the possibilities of surviving on its own. Soon, even researchers will be unable to follow their study subjects in their fractal environment.

Likewise, the development of the Mediterranean coastline to meet the demands of fellow European vacationers is far more damaging than climate change or other environmental threats. And while the transfer of water between catchments is halted on environmental concerns, desalination plants may soon dot the whole Mediterranean coastline to allow housing projects to continue, along with habitat destruction and pollution of lands and waters. As an example of the magnitude of this trend, in a province like Almeria (500,000 inhabitants, 200 km coastline) 200,000 new houses will be built in the coming five years. The habitat devastation of this building project exceeds by far other environmental problems. But no policy maker would dare to suggest that coastal areas should be developed in a sustainable way (a concept most of them restrict to organically grown food).

In sum, although the identification of minute lacks of knowledge regarding the role of biodiversity on ecosystem function and services, and the design of best ways to preserve species is very important, I think that at this moment it is critical to pressure politicians to consider criteria other than short-term economical profits when taking decisions. Now and here, it is not only a matter of better knowledge, but of changing livelihoods, as earlier contributions pointed out.

Research which makes a difference

Caspian Richards, Macaulay Institute, UK

A common theme in a number of posts has been the need for researchers to develop a more worldly outlook, where we are able to identify areas of work where our contribution might make a difference, rather than continuing to formulate our views with no reference to real world conditions, and then to bewail the fact that no-one listens. It is clear from the views expressed here that this means (on the whole) addressing the big questions (e.g. how can we collectively save the planet, not in theory but in practice?), and trying to piece back together the fragmented ways we have been taught to think.

In terms of research, much of what we therefore need is a rearguard action to address our own historical shortcomings, learning to combine an awareness of the concerns and circumstances of real people with a job which entails devoting one's time to reflecting upon them in the aim of improving the collective lot. We need to be able to understand, in particular, how decisions with impacts on biodiversity are currently taken (I mean really taken, not taken according to some lop-sided model from economics, psychology or wherever), at the level of both institutional policy-making and individuals; what influences those decisions and what new influences could play a part; how we might provide inputs that will be valued by decision-makers (and we are all that) and those who live with the consequences of them (and we are all that too).

Much of this seems to me pretty simple, requiring no method more sophisticated than ears and eyes - in fact, one of each should suffice. Anyone equipped with the aforementioned would be capable of carrying out research of this kind, perhaps one reason that it offends the pride of many to descend to such simplicity. From that point of view, I think that rather than arguing for the inclusion of specific items on the research agenda, I would suggest that an overall approach based on an ethos of orienting ourselves towards the world rather than inwards is much more important - once we get that right, we will be better equipped to put together an agenda which reflects the prospects of having a substantive influence. We might then be in a position to answer David Coates's demand for examples of where our research has made a difference in practice.

Interdisciplinary research

Rehema White, Centre for Ecology and Hydrology, Banchory, UK

The discussion on interdisciplinary research in this e-conference has been interesting. In some sessions it seems that people are still extolling the need for interdisciplinary research whilst in others they are debating how it can best be achieved.

As Caspian and others have noted, there is some tension between different areas of research. Perhaps some of this tension comes from the fear that it may lead to inferior study with the most rigorous standards of excellence in each discipline relaxed. Some of it appears to be the fear of ignorance where, as Sandra pointed out, the intellectual foundations of disciplines are so different. Yet some researchers are happily conducting interdisciplinary research and are exchanging new ideas and tools across disciplines. The rapid development of decision-making systems in management and social sciences and their recent adoption in environmental science is an example. I recently developed a list of current journals that publish interdisciplinary papers (NRM/environment with strong social or economic perspective) and there are several new journals and a few that have changed title and focus to reflect the need for such work. However, there are problems with refereeing in that most specialists reviewing a paper wants to see more of their own discipline.

Perhaps what will happen is the development of interdisciplinary research as a new discipline at the interface of others. People will train in this discipline and be able to see across fields and intellectual boundaries. (To some extent environmental science does this already). Such researchers would be akin to the early natural historians who were often knowledgeable in many fields. A return to this situation is seen in countries where legislation and processes for EIAs demand consultants with basic all round skills.

But an increase in knowledge and progress within disciplines means that to be very good within a discipline, an individual must usually be a specialist. The general outlook thus needs to be countered by the presence of experts in each discipline within interdisciplinary teams. A combination of generalists, who can bring different strands of research together, and specialists, who remain within disciplines but with a willingness to acknowledge the excellence of others and to participate in debate, may be one way to achieve interdisciplinarity. This may also be one way to alleviate the fears that excellence may be compromised and to dispense with the need for everyone to know everything.

Monitoring, Indicators and Reporting

Research needs for Monitoring, Indicators and Reporting: Opening Statement

Allan Watt, Session chair, Centre for Ecology and Hydrology, Banchory, UK

As the participants of this e-conference know, the European Commission is currently coordinating a review of the implementation of the European Community Biodiversity Strategy and its associated Biodiversity Action Plans (BAPs). Other sessions in this e-conference will discuss research needs in relation to these BAPs. This session will discuss research needs for monitoring, indicators and reporting on biodiversity. This subject is a critical aspect of the Strategy and BAPs. For example, the Strategy states that the "identification of these indicators and the monitoring of [biodiversity change] is an essential element of this strategy because it will provide the required information to assess the performance and impact of the Action Plans and other measures". Since the Strategy was written, the need for monitoring in relation to policy goals has become even more important with both an apparent, but poorly quantified, decline in global biodiversity and also the agreement by EU Member States to halt biodiversity loss in Europe by 2010.

This e-conference is not only about research needs for quantifying trends in biodiversity, it is about research needs for monitoring to identify and quantify the causes of biodiversity change and about research needs for monitoring to evaluate the contribution of measures taken to conserve biodiversity, such as the BAPs themselves. For example, the Strategy and BAPs express the need for in indicators to assess the impact of '*inter alia* … unsustainable harvesting, emission of pollutants and release or spread into the environment of alien species and genetically or living modified organisms", and for "timely reporting on the implementation of both [the Birds and Habitats] directives".

This e-conference is not about the need for monitoring, indicators and reporting per se: there is surely no argument about the fact that information on biodiversity is necessary to effectively address biodiversity loss. How we should monitor biodiversity is, however, unclear. Nevertheless, this e-conference should not be used to argue for particular approaches to monitoring biodiversity, nor for particular biodiversity indicators. Rather, this e-conference will discuss research to implement proposed methods for monitoring, indicators and reporting. It will also discuss research to develop better approaches to monitoring, indicators and reporting.

As background information, it is worth considering the following list of indicators for measuring progress towards the 2010 target. This list was agreed by the European Commission Working Group on Monitoring, Indicators & Reporting on the 2nd April 2004. The working group identified three levels of indicators:

- Level 1. A single structural indicator for biodiversity to inform policy makers and the public about the condition of biodiversity in a very generic way
- Level 2. Headline indicators for biodiversity that provide a more detailed picture of trends in various aspects of biodiversity.
- Level 3. Indicators linked to policy sectors, specifically designed to inform stakeholders about how their actions influence biodiversity.

The list was based on the CBD COP-7 agreement (http://www.biodiv.org/doc/meetings/cop/cop-07/official/cop-07-l-27-en.pdf), and on the EEA core set of indicators (http://ims.eionet.eu.int/Topics/BDIV) and can be considered in six groups as follows:

Group A: Status and trends of the components of biological diversity

1. Trends in extent of selected biomes, ecosystems and habitats
2. Trends in abundance and distribution of selected species
3. Change in status of threatened and/or protected species
4. Trends in genetic diversity of domesticated animals, cultivated plants, and fish species of major socio-economic importance
5. Coverage of protected areas

Group B. Sustainable Use

6. Area of forest, agricultural, fishery and aquaculture ecosystems under sustainable management
Group C. Threats to Biodiversity
7. Nitrogen deposition
8. Numbers and costs of invasive alien species
9. Impact of climate change on biodiversity
Group D. Ecosystem integrity and ecosystem goods and services
10. Marine trophic index
11. Connectivity/Fragmentation of ecosystems
12. Water quality in aquatic ecosystems
Group E. Status of access and benefits sharing
13. Patents (to be developed)
Group F. Status of resource transfers and use
14. Funding to biodiversity
Group G. Public opinion
15. Public awareness and participation

On 21st - 23rd April in Copenhagen, a BIO-MIN meeting will, amongst other things, assess the practicality of acquiring the data needed to establish these indicators.

This session of the e-conference will be in three parts: it will consider the research needed to ensure that we can adequately monitor 1) changes in the state of biodiversity, 2) the impact of single and multiple drivers of biodiversity and 3) the impact of policy responses to biodiversity loss, particularly the measures included in the BAPs, the overall impact of the Strategy and the 2010 target to halt biodiversity loss.

In this first part we will consider the need to know the state of biodiversity and how its state is changing. We will consider research needs for monitoring habitat extent and quality, monitoring species diversity, monitoring genetic diversity and the development and implementation of indicators of biodiversity. Contributions should either focus on research needs (if any) in support of the above list of indicators, directly or indirectly, or they should consider research needs for improved ways of monitoring biodiversity. In considering the indicators in the above list, contributions should, in this part of the e-conference, only deal with the indicators that deal with the state of biodiversity, that is, Group A.

We look forward to your contributions for this important discussion. The conclusions of the e-conference will feed into the of the EPBRS meeting under the Irish Presidency from May 21 to May to 24, 2004 in Killarney.

Research needs for monitoring habitat extent

Katalin Török, Ministry for Environment and Water, Bureau for Nature Conservation, Budapest, Hungary

SUMMARY: Re-mapping of habitat extent requires research taking into account proper time-scales, sampling methodology, state assessment and remote sensing.

The network of Natura 2000 sites will probably provide the main source of information on European habitats. At the moment, baseline data are gathered on the selected sites and the rate of different habitat types represented in the sites are given for each country. As a result, an estimate of total cover of the types listed in the Annex of the Habitat Directive, that is, habitat extent (in ha) for each member state will be available. Monitoring is an important task for the coming years.

What are the premises of the reliable monitoring of habitat extent?

Changes can be detected by re-mapping, that requires: proper time-scale of repeated sampling; standard methodology at the defined spatial scale (1:100 000 at the moment); state assessment of the habitat and repeated estimate of proportion of selected habitat types in relation to national extent.

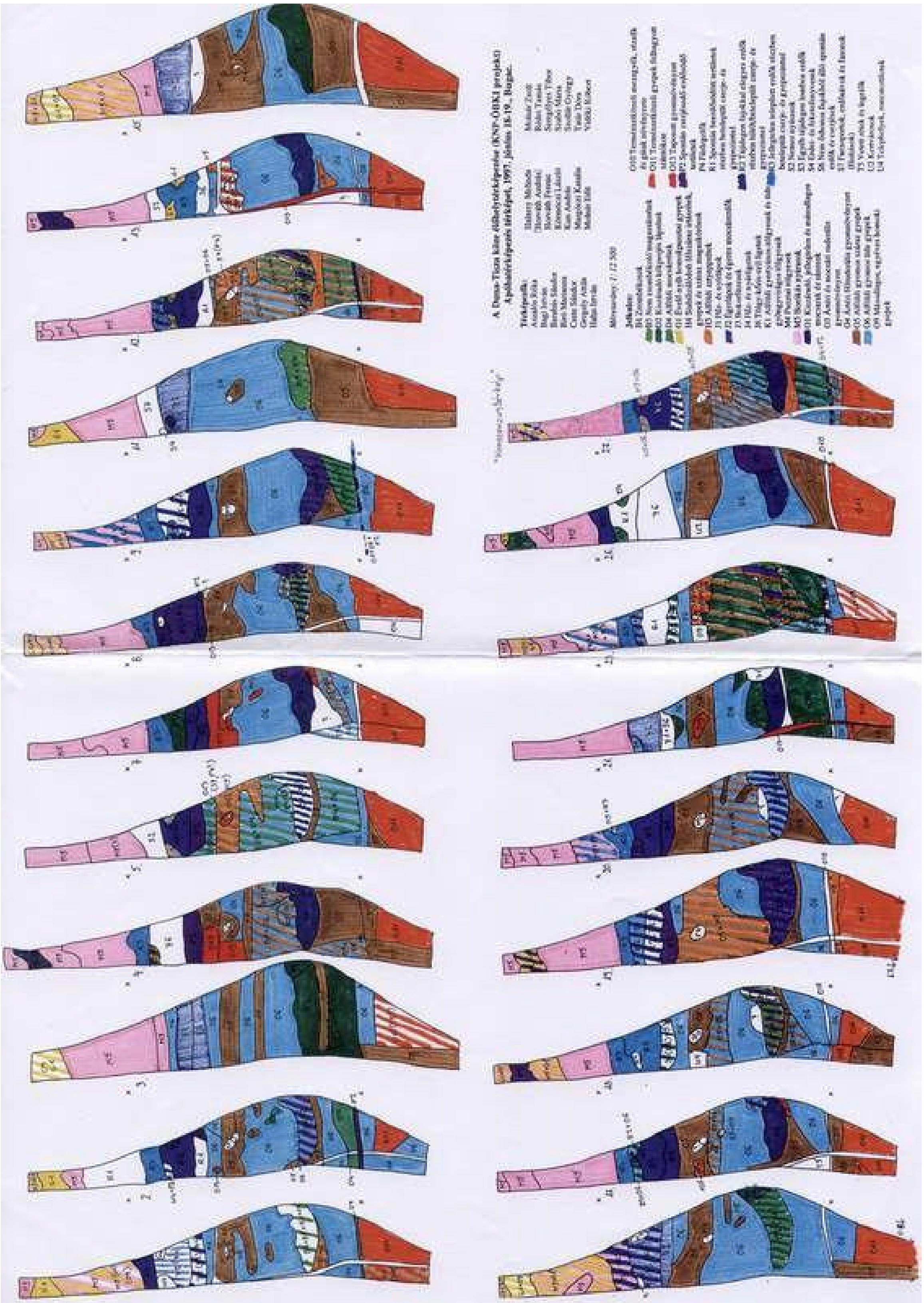
There are important knowledge gaps concerning the listed requirements, which would need further research:

- Different habitat types can have different dynamic properties; therefore, the detection of the changes should ideally be according. This is not likely to happen for Natura 2000 sites, but an estimate of the best sampling frequency for each habitat type, and a uniform optimal frequency should be decided, based on research.

- Vegetation mapping repeated by different experts has demonstrated that standard methodology is required to minimise the effect of subjective decisions in the field. For an example see the vegetation maps of the same area in Hungary prepared by 20 vegetation scientists at the same time (see attached maps). A consensus map (upper right) was also produced during the standardisation process. To re-map the borders of a previously designated area is less difficult, however, it raises several problems (fuzzy borders, how and what to record in the field etc) where research is needed.

- When re-mapping, one also has to whether the habitat can still be classified in the same category as designated before. This requires state assessment in the field (or during data analysis). There is no accepted way of describing the natural state or of defining the criteria of habitat identity. Research is needed to identify structure and function indicators (e.g. ensure habitat of protected species).

- As a rule, a minimum 20 % of the listed habitat area has to be designated. In order to conserve habitats, a re-estimation of the proportion designated should be carried out at defined intervals (preferably during re-mapping). Remote sensing could be used as a tool. Remarkable research is carried out in this respect (Symposium: State of the Art in Vegetation Monitoring Approaches), but the methodology has to be adapted to the required scale.



Research needs in relation to monitoring plant species diversity

Jan Jansen, Experimental Plant Ecology, Department of Ecology, University of Nijmegen, The Netherlands

SUMMARY: Research is needed in comparing and evaluating all existing flora and vegetation monitoring projects, including methods and technical aids. The outcome enables us to make the best choice (and possible improvements) gaining broad consensus creating one reliable, standardized, mutual compatible and pragmatic Pan-European monitoring system.

Nature conservation organisations and private owners benefit from monitoring programmes that measure the effectiveness of the applied management techniques and that identify the impacts upon plant species and plant communities. Monitoring programmes are also indispensable tools for decision makers, measuring the effectiveness of nature policy and to screen the likely effects of all kind of activities in or near the sites where the habitats and species occur (Jansen 2002). These decision makers include the EU, the national authorities, the regional governments and the municipalities.

Relatively small areas may be monitored entirely, but extended areas cannot be covered totally, in particular in the countryside where changes in land use nowadays are often quick and booming. This raises the problem of sampling: at random or in selected areas? Practically it is quite impossible to monitor all plant species, raising the problem of which taxa need to be selected (indicator species).

Despite the efforts that have been made for developing sound indicator sets and monitoring schemes there is still a big discrepancy between the scientific development and the policy requirements (Anonymous, 2002). Therefore research is useful, in particular in comparing and evaluating all existing monitoring projects and methods. The result should be one reliable, standardized Pan-European monitoring system that will meet all major needs of politicians, land managers and critical ecologists.

On the local level a number of initiatives have been taken. These initiatives are welcome, but are particularly valuable when compatible with one coordinating system. At the Dutch province Noord-Brabant a first initiative of standardization was taken by converting the old vegetation typology into both a consistent and pragmatic system that was directly linked to the national classification system and indirectly to the European Corine and Natura 2000 classification (Jansen 2001). However, the method of route monitoring to measure the effects of the province's policy ("nature's state of the art") deviates from the permanent plot method used on the national level. It is likely that all expensive efforts to obtain information will eventually be in vain when it turns out that this system is not compatible with the national monitoring system. There is clearly a need for gearing monitoring systems to one another. Here lies an important task for the EU, taking the lead in providing a waterproof standard for policy related monitoring programmes in its member states (e.g. monitoring the obligations of article 6 of the "Habitat Directive").

In addition we need more pragmatic research on how we can carry out the monitoring most effectively. We often hear that we cannot afford long-term monitoring of plants and plant communities. Qualified fieldworkers have experience, know the terrain, know their plants, and they deliver the fundamental information to which the data system is based upon. However, research is needed in the optimisation of technical aids for fieldworkers, such as the use of palmtop computers for data entry, GIS technology, remote sensing and standardized data management programmes that are mutually compatible. In addition, procedures should be simple and effective. This year, the fieldworkers from the bureau of Monitoring & Evaluation (province of Noord-Brabant) are expected to use palm computers equipped with specific software, potentially saving the Bureau hours of work. This can be invested in shortening the rotation period of the monitoring programme, showing increased resilience. Nature's state of the art can be presented quicker and as a result the feedback period from

politicians or land managers reacting on adverse booming effects on species and habitats will be shortened too.

Evaluating existing flora and monitoring programs

Klaus Henle , UFZ Leipzig-Halle, Germany

Jan Jansen recommended research to create a reliable standardized Pan-European monitoring system for flora and vegetation. Non-standardization is an even greater problem for most faunal monitoring done in Europe. I agree that a compilation and standardization of existing monitoring schemes would be of great benefits. However, we need to be realistic and this did not even happen within larger countries such as Germany, where each Federal state uses different monitoring schemes. Therefore, it is at least as important to develop methods that allow to draw as much information as possible out of a combination of monitoring schemes that differ in methods.

RE: Evaluating existing flora and monitoring programs

Jan Jansen, Experimental Plant Ecology, Department of Ecology, University of Nijmegen, The Netherlands

Klaus Henle correctly noticed that non-standardization is even a greater problem for most fauna monitoring done in Europe. In contrast to flora and vegetation, fauna is moving instantly. Related to the properties of the animals (e.g. avifauna, herpetofauna, arthropods), the way of monitoring them might differ. To create a reliable standardized Pan-European monitoring system, for each group the best way of monitoring should be known and consequently applied.

Some programmes that monitor flora and vegetation seem to have been derived from fauna monitoring approaches. Some organisations in The Netherlands use the method of route-monitoring, developed by Everts & De Vries (1994). How reliable are the results? Here research is needed too. Shouldn't we scientifically test such a method and compare it with the broadly applied monitoring method of permanent (multiple) plot sampling?

Monitoring habitats and biodiversity

Felix Herzog, Swiss Federal Research Station for Agroecology and Agriculture, Zurich, Switzerland

I was very interested to read the contributions of Jan Jansen and of Katalin Torok on the need for species and habitat monitoring and the problems associated with this.

Let me just draw your attention to the BIOHAB project www.biohab.alterra.nl, where we try to deal with these difficulties. We want to come up with a methodology which allows to produce consistent habitat information across Europe, suitable for monitoring. This involves a lot of very detailed work on definitions and rules!

RE: Monitoring habitats and biodiversity

Alan Feest, University of Bristol, UK

Felix is right to suggest that a consistent approach is required across Europe to measure biodiversity. But there are problems:

1. The definition of biodiversity (CBD, 1992) seems to regard biodiversity as comprising of a list of species and yet our discussions seem to revolve around other elements of biodiversity such as rarity and indicator status

2. The use of indicators as being politically acceptable (and often small furry and cuddly or big and fierce!) or easy to identify and record has led to over reliance on indicators despite the lack of reliable information on the effectiveness of their power to indicate (and often a failure to define what it is they are indicating).

3. The need to devise methodologies that allow for the changing status of the species present in a habitat either through species turnover (immigrants and emigrants) or increase and decline of population numbers (not indicated in lists)

4. The need for a defined sampling strategy that allows for comparisons across taxonomic groups or standardisation of information. Frequently surveys fail to identify: a) the expertise of the recorders b) the effort input c) the area surveyed or d) the method used for observing the species or even what a species might be defined as comprising.

5. The assumption that biodiversity can be indicated by vegetation components whereas experimental evidence indicates that for invertebrates and particularly vertebrates we know that it is the physical characteristics (temperature, vegetation architecture, rainfall etc.) of a site that are as important as the vegetation species.

6. The need for a methodology that allows for the establishment of biodiversity as a QUALITY with a variety of characteristics.

If this last point is taken as a starting point one should be able to define biodiversity by the measurable characteristics and I have used the following:

- Species list (the number of species recorded for a site over defined and stated number of years and/or visits using a standardised methodology). It is surprising how few surveys can even comply with this simplest of measures.
- Species Richness (the number of species in a defined area of a site at the time of the standardised survey)
- Biodiversity Indices (Simpson's, Shannon-Wiener etc.), which despite their name are, really measures of evenness rather than biodiversity. These will need a standardised survey for comparability between sites. They can produce nonsense data such that a site with ten species has a much higher index than one with a hundred species.
- Biomass; it is often possible to calculate this by simply counting the numbers of individuals in the survey for each species and relating this to the data on size given in the identification handbook. I have done this for macrofungi and beetles and it works very well with correlations with $p=3D<0.001$. Despite this statistical significance this is still an inferred

biomass and an index number is used for relating through time or between sites. The linear regressions could be used to define the actual biomass but does this really move the debate forward? Biomass is important in biodiversity as it relates to the interface between species as prey or predators etc.
- Species Value Index (this is generally taken as based on the relative rarity of the species as this often the only indication we have of the ecology of the species e.g for macrofungi or beetles or spiders but could be based on value as an indicator of habitat quality or intrinsic value).

All of these require a standardised sampling process. If a standard process is used then not only can site indices be compared through time or with other sites but an understanding of biodiversity QUALITY can also be gained by reviewing the relative balance of the indices.

I have worked on this problem for a number of years now and have some answers to these problems and recently presented a paper in Berlin, which will be the subject of an article in Restoration Ecology. I have also contributed to a number of these email conferences and despite the general agreement for the need for standardisation of sampling we seem no nearer then when we started in stimulating a general philosophical structure for sampling. I would have thought that this was the basic priority for moving forward in the conservation of biodiversity. Does anyone agree?

RE: Monitoring habitats and biodiversity

Kajetan Perzanowski, Carpathian Wildlife Research Station, Poland

I absolutely agree with Alan Feest's call for urgent formulating a universal method to measure and compare biodiversity (through time and among sites). For quite obvious reasons this cannot be too complicated and requiring advanced technologies so at the moment genetic diversity (although probably being the most universal) cannot be considered. A very promising approach is the proposed description of biodiversity as a quality - I would add here also a point reflecting the habitat complexity.

The other way around is to look for species (umbrella type) whose presence (and relatively high numbers) are indicators for high quality/high biodiversity of a site. Following this way of thinking, though, most probably we would end up with "politically acceptable, small furry and cuddly or big and fierce creatures!". Perhaps the option here could be selection of certain types of habitats, of regional importance with proved high levels of biodiversity.

However, whatever approach could be commonly accepted, it would require an introduction of long-term monitoring programs (the idea not very popular yet in Europe), as the only way to answer the question whether observed changes are only seasonal/random fluctuations, or if they reflect truly significant changes in a number of species, population trends, and habitat quality.

I am afraid that without such pan-European program, involving a network of sites, routinely monitored according to standardised methodology for a number of years (just like present weather stations) we will not go much further with assessment of biodiversity loss.
I am rather pessimistic regarding the possibility of reaching such large scale estimate based on results of randomly selected studies.

Research needs for using soil fauna as indicators of biodiversity in bio-monitoring programmes

Paulo Sousa, Instituto do Ambiente e Vida, Universidade de Coimbra, Portugal

SUMMARY: More research is needed in different bio-geographic areas on finding surrogate groups for overall below ground biodiversity and surrogate taxonomic levels for certain groups.

Soil fauna have the potential to be used as indicators of biodiversity in monitoring programmes, since they follow some of the requirements of good indicators. However, when embracing a group of organisms as diverse as this one, we face (at least) two major problems. The first one is related to the existing difficulty in identifying such a wide range of groups at a lower taxonomic level (genus or species). The second one is related to the time spent on that identification (with the corresponding costs), making it difficult to have results over a relatively short period of time.

The solution to both problems arises by finding the appropriate surrogates depending on the questions we want to address. If our aim is to use a group as a surrogate for the overall below ground diversity, we probably don't need to identify all groups at all. However, the solution in soil may not be a single surrogate group for all edaphic fauna, since different groups might react to changes in soil 'quality' in a different way. Recent results obtained in the BIOASSESS project revealed that Collembola species data was not well correlated to soil macrofauna data (identified mostly at family level). This might indicate two things: first, that a finer identification was needed on the soil macrofauna to really verify if the two groups were correlated in terms of species number, and second that maybe a surrogate at different levels should be found (e.g., meso and macrofauna). In terms of research needs, this implies the need for more data on a wider range of edapho-climatic conditions to verify the relation between different soil fauna groups, and to check if the same surrogate(s) could be applied to all bio-geographic areas of if bio-geographic specific surrogate(s) should be found. Of course this poses an interesting question that if the groups we are used to identify (because we are experts on them) are the most appropriate ones. But I don't want to follow that path here.

However, we can have other objective in mind. We simply need to evaluate the richness of a certain group in a certain area. In this case the solution could be simpler, and simultaneously solve the time problem; nice data already exists for some groups showing that working on a higher taxonomic level can indicate the number of species present quite well. We have examples from spiders (the recent paper on Biological Conservation showing that genus are good surrogates for species richness), some groups of soil macrofauna (BIOASSESS data at family level), and collembola (also BIOASSESS data and working at genus level). In terms of research needs, again, data on more groups and on a wider range of bio-geographic areas is needed to verify the relation between different levels of identification.

Last but not least, some of these problems could be partially solved with the existence of a good database on soil fauna, namely mesofauna, since for soil macrofauna the TSBF database is an excellent one. As mentioned, part of the solution could be simply on data treatment.

Microbial diversity: monitoring even if we only know the 'tip of the iceberg'

Annick Wilmotte, Centre for protein engineering, University of Liege, Belgium

SUMMARY: Research is needed to increase our limited knowledge of the microbial diversity in the environment and at the same time, we need to continue looking for indicators, comparing and improving the methodologies.

In a discussion of the implications of the CBD for microbiology and microbial resource centres, the lack of knowledge was cited as the first difficulty to address. Indeed, only between 1-5% of the world's microbial species are known (www.bdt.fat.org.br./bin21/proceed94/convent.html). Thus, the best basis to undertake a microbial diversity monitoring would be an inventory of the micro-organisms in the biota under investigation, in a fashion similar to inventories of butterfly or lichens species. Crozier (1997) stated that "Complete enumeration of biotas in terms of phylogeny is desirable to avoid uncertainties in the use of indicator groups, and this is now achievable for bacteria". Indeed, monitoring tools are available for micro-organisms, based on their physiological activities (e.g. BIOLOG system), bio-chemicals (e.g. fatty acids, quinones, pigments) and genotypes (e.g. ribosomal RNA gene sequences). However, the goal of complete enumeration is a real challenge, due to technical limitations and the high microbial diversity (4000 bacterial genomes in a forest soil sample following Torsvik et al., 1990). We are only starting to accumulate the genotypic data that is necessary to study whether endemic micro-organisms exist (Hedlund & Staley, 2004) and the issue is still controversial (Finlay & Esteban, 2004).

In this context, I see two possible options for studies to improve microbial monitoring, which are in fact complementary:

- Obtain a more complete and detailed picture of microbial diversity. Knowing that a majority of the species are not cultivated (or not yet in culture), this inventory must be based on genotypic markers. These have traditionally been based on molecular taxonomic markers like rRNA or other gene sequences that can be used as 'signatures'. In addition, recently, genomic approaches were applied to a Sargasso Sea sample by Venter et al. (2004) and revealed more than 1.2 million genes in this oligotrophic environment.

- Work with the present knowledge of microbial diversity and search for indicators and reporters, being aware of the actual limitations. At present, this is generally carried out by four different approaches. The community fingerprinting techniques (like Denaturating Gradient Gel Electrophoresis, Single Strand Conformation Polymorphism, Terminal-Restriction Fragment Length Polymorphism) produce banding patterns that can be compared to assess changes and dynamics. The Fluorescent In Situ Hybridisation allows detecting and quantifying the presence of a particular genotype in a sample. The Polymerase Chain Reaction with specific primers enables to detect the organism of interest, and Real-Time Quantitative PCR can be used as a sensitive assay. Over the last few years, DNA microarrays have been developed to perform environmental diagnostics based on the hybridisation of a high number of genotypes in one experiment.

For all these methods, there is a need for automated and High-Throughput implementations that facilitate the different steps (sampling, DNA extraction, data analyses….). The final purpose would be that some of these techniques become simple, fast, and cheap enough to be used in routine. In addition, comparative studies are quite limited, and a methodological research where different approaches are used on the same sample in different laboratories would be very useful. It reminds me of the European programme 'Tools for Biodiversity' coordinated by Angela Karp (University of Bristol, UK) that included research but also summer courses.

Brief considerations on the relative merits of direct monitoring and indicators of biodiversity

Frédéric Gosselin, Cemagref, France

SUMMARY: Monitoring of biodiversity as a whole is impossible. Monitoring parts of biodiversity is welcome. Indicators are a good complement to monitoring, provided their quality has been tested.

Monitoring, indicators and reporting are really three different parts of the same tool, used to detect or predict evolutions of biodiversity. In itself, direct monitoring of interspecific and intraspecific biodiversity raises much less scientific critiques than indicators. The main problems with monitoring are (i) its cost (if we want to monitor a great part of biodiversity); (ii) its incompleteness (because it is practically impossible to monitor the whole of biodiversity) and (iii) its complexity and hence the difficulty to report the results and decide. To me, this is the second problem – the incompleteness of biodiversity monitoring – that makes the use of indicators of biodiversity necessary.

However, the quality of indicators depends on the reliability of the relationship between the indicator and the variable it is supposed to assess. Intuitive indicators can indeed be more useful to reach social consensus, but they are a danger against long-term quality of the system if they have not been tested in the field. Also, general scientific concepts, if applied without any confrontation with field reality and variability, could lead to erroneous indicators (Bunnell & Huggard, 1999). Indeed, it seems relatively general in ecology that a concept or a pattern does not apply or is not dominant generally, but its dominance depends on the length of and position on the ecological gradient concerned. Besides, we must define precisely which part of biodiversity an indicator indicates; and we must be careful about indicators that try to indicate only local species richness of some communities, since some species of these communities could well behave differently from the other species. A pure maximization of species richness might well yield finely fragmented landscapes, with a lot of edge effects, which would very probably be unsuitable for a number of species.

The development of indicators should therefore be followed – or best preceded – by a test of their validity, both in terms of ecological conditions and taxonomic units that are concerned. This should be done by (i) extensive field tests; (ii) meta-analyses of existing data and/or (iii) understanding of the mechanisms behind this indicator (Bunnell & Huggard, 1999). Complex versions of the indicator could also be compared to simpler versions, and to other types of indicators, through techniques of model comparisons based on multiple hypotheses (Anderson *et al*, 2000; Chamberlin, 1965). A dynamic view of indicator quality test should be preferred to a static one, since scientific conclusions evolve (e.g. Simberloff, 1988) and data collection continues.

In the absence of such analyses, direct monitoring of inter- and intra-specific biodiversity at the European level is a better, more robust solution, provided we clearly justify which taxonomic or ecological groups are assessed. There are several examples of national biodiversity monitoring schemes that are based on this premise. In this context, techniques that allow analysis and communication of the results are the focus. We finally insist that monitoring, indicators and reporting are only one part of the story: they would very much be enhanced when used in parallel to or within experiments or adaptive management.

Developing and evaluating indicators

Robin Moritz and Peter Bliss, Institute of Zoology, Martin-Luther-University, Halle-Wittenberg, Germany

SUMMARY: It may not be possible to develop indicators for biodiversity, but the development of indicators for the biodiversity potential of habitats might be a feasible and desirable tool for biodiversity conservation.

The indicator approach was originally developed by fresh water ecologists to assess water quality by a suite of indicator species rather than using elaborate chemical analyses (Rosenberg & Resh 1993). In developing indicators for terrestrial ecosystems we might keep this original approach in mind. Transferring the concept of monitoring water quality to habitat quality, we should assess habitat quality by typical and abundant species (something like "habitat plankton"). Species exploiting habitat resources above and underground seem to be most suited, because they are simultaneously affected by various habitat strata. Microbial and fungal organisms should definitely be included in such an assessment because they dominate soil strata. Moreover long-lived sessile species may be good indicators because they "sample" habitat quality over long periods of time. Long-lived perennial plants are already used to classify habitat type and quality, but also animal systems such as ants and termite nests can survive for decades at the same site and provide excellent monitoring properties that are rarely used in assessing habitat quality (Andersen et al. 2002).

Mobile animals might be able to respond more swiftly to habitat changes, but does this help for indicating? How can we interpret a decline of a migratory species at a given site? Is it because of the poorer conditions at that site, or is it because of a disease, death, habitat destruction at yet another site where the animals migrated from? For most species we don't know. It requires a global knowledge to address this point (which we may have for many birds) but clearly it complicates the evaluation of the indicator at the local level. Species relying on various independent habitats, require extreme (often global) surveillance efforts to identify causal mechanisms for species decline. Rare species are unsuitable for habitat assessment because variance in abundance may be exclusively due to stochastic sampling errors. Rare "Red List" species are therefore inevitably poor indicator species for anything they are supposed to indicate.

Although it seems feasible to develop indicators for habitat or ecosystem quality, it seems much more difficult to develop indicators for biodiversity. What indicators can do is to reflect a good habitat quality, which might give an opportunity for a rich and typical biodiversity. However, the biodiversity potential alone does not tell us much about the realized diversity of species in any given habitat. Assessing actual biodiversity requires labour and time intensive monitoring with a great amount of uncertainty. Various biodiversity measures have been developed, but none of them relies on specific indicator species for biodiversity. Even if such indicators were available, it might be useless from a standpoint of biodiversity conservation. For conservation purposes we would not like to see biodiversity maximized in certain habitats (any zoo would be a biodiversity hot spot). We prefer to see a rich endemic biodiversity, typical for the habitat in question, and preserving conditions allowing for long-term opportunities to support biodiversity. It seems therefore worthwhile to re-evaluate the properties of currently used habitat and ecosystem quality indicators. Many of them appear to be simply in use because of political or historical reasons rather then their ecological significance for reflecting habitat quality for biodiversity conservation.

RE: Developing and evaluating indicators

Katalin Török, Ministry for Environment and Water, Bureau for Nature Conservation, Budapest, Hungary

I would like to argue with considering rare species unsuitable for indicating state. Single species really have the disadvantages mentioned, but if we consider them as a group, they can provide a more reliable estimate of habitat quality than frequent, common species.

RE: Developing and evaluating indicators

Sue Mainka, IUCN

I would also like to take exception to the idea that threatened species would not provide a useful indicator for monitoring biodiversity. Here at IUCN we have been undertaking assessments for our IUCN Red List of Threatened Species. As a logical next step we are developing a Red List indicator, which will be based on the Red List assessments. This indicator will be based on two broad classes of data. One (non-sampled) is based on the Red List assessments of all taxa for groups, such as birds, in which all species have been assessed more than once. The strength of this indicator is that data for one group (birds) extends back to 1988. However, the number of completely assessed groups over longer time frames is currently limited: by 2010 data will be available only for birds, mammals, and possibly amphibians. To address this taxonomic bias, the second (sampled) indicator is under development. This is based on a representative sample across all major taxa, stratified according to significant parameters such as broad biome, region, taxonomic group (e.g., phylum) and Red List category. This suite of species would be regularly reassessed, and overall changes in status could be taken to be representative of wider biodiversity. While we don't expect this to be the entire answer to biodiversity indicators, we feel that information about threatened species can provide some useful knowledge.

RE: Developing and evaluating indicators

Robin Moritz and Peter Bliss, Institute of Zoology, Martin-Luther-University, Halle-Wittenberg, Germany

We got a few replies suggesting that threatened (rare) species can be good indicators for habitat quality, if they are considered as a group (Katalin Torok). Unfortunately, no recipe was given for how this could possibly work and why rare species are going to better indicators than frequent ones typical to a habitat. We don’t see an easy solution to the sampling error problem even when adding many rare species. Moreover, we question that rare species are more relevant to habitat quality than frequent species.

We probably all agree that it is anthropogenic extinction of species that we want to avoid by conserving biodiversity. We do know that it happens all the time with a large number of species, some of them listed by the IUCN but many not. Given that there are thousands of species that get extinct before we even know they are there, the red list is primarily a political tool to let all know that something is at stake. The question is how to develop reliable and robust indicators for extinction processes and biodiversity loss in spite of our ignorance. In this respect rare species (whether on red lists or not) may be less suitable than abundant ones.

Given that we barely understand the complexity of ecosystem functioning, we don't understand why monitoring locally rare red list species is going to inform us on sustainable habitat quality. Red lists have been developed for an entirely different purpose than for monitoring habitat quality. We should keep this in mind when developing monitoring tools for local ecosystem management. The red list instrument can provide additional information but should not be the prime monitoring tool for evaluating habitat quality.

RE: Developing and evaluating indicators

Sue Mainka, IUCN

Yes, I agree that the Red List was not developed to monitor habitat quality directly but I do believe that by understanding trends in species that are specific to a habitat type we can have a proxy for what might be happening to the habitat. It is also important to note that the Red List includes non-threatened as well as threatened species and we are trying to include longer term monitoring of a representative group of species (threatened and not) that is better able to provide the indicators we are looking for. We have a long way to go in developing working indicators but we should make use of what is already out there (both in governments and civil society) rather than re-inventing wheels.

RE: Developing and evaluating indicators

Katalin Török, Ministry for Environment and Water, Bureau for Nature Conservation, Budapest, Hungary

Rare plant species are used in the estimation of "naturalness" of habitat types. There is a system of grading at a scale of 1-5, based on Seregélyes- Németh for the Hungarian habitat types. An ambitious project is going on to make the inventory and state assessment of habitats possibly covering the whole territory of Hungary. This grading system will be used for estimating "naturalness", that is a complex measure based of species richness, degradation, European/national "uniqueness". The grades are:
1 - degraded, the original habitat is hard to distinguish, weeds dominate
2 - degraded, elements of the original habitat are rare, their proportion differs from natural, weeds dominate
3 - disturbed, elements of the original habitat according to natural ratios, rare species may occur, weeds and "characterless" species are abundant
4 - semi-natural, human influence low, species number close to natural, rare species present, weeds subordinate
5 - natural (or close to natural), rare species (most of them protected, or endemic, relict) common, weeds rare

The importance of "rare" species in this evaluation system is self-explanatory. These are called "coloring elements" among Hungarian phytosociologists, and this expression is used for describing the value of different plant associations for decades. I admit that this is a subjective estimation of quality, but with the help of detailed description of how to estimate the grades for EACH habitat type, with species lists etc. is a very good tool for monitoring natural state. This is only available in Hungarian at the moment.

I hope this helps to understand what I was trying to explain in my previous contribution. I am sure that only similar assessments can help to detect early degradation processes. In levels 3,4 or 5 the different occurrence of rare species is an important measure.

RE: Developing and evaluating indicators

Per Sjögren-Gulve, Department of Conservation Biology and Genetics, Uppsala University, Sweden

Both valuable habitats and selected species need to be monitored (see my contribution in the BAP Natural Resources Session). Species monitoring is needed to cover spatial aspects of the conservation work: e.g. that habitat is conserved and surroundings managed so that dispersal and recolonization processes work in a “metapopulation” system. Presence or absence of certain species may also reflect important historical events or conditions. About what species

to monitor, indicative species from a number of indicative groups need to be used (Roberge & Angelstam 2003). Using a nested-species-subsets methodology to analyze species occurrence patterns, if possible expanded as in Fleishman et al. (2000), seems illustrative and promising in the identification of potential "umbrella species" (see also Liam Lysaght's ""Research needs and support services" in BAP-Agriculture, Klaus Henle's contribution "Structural changes of landscapes" and other contributions in this session). Regarding "umbrella" or "indicator" species, the rare species may not generally be the best indicators. However, studies suggest that some species with intermediate regional abundances often have high indicative values (e.g. Wilson et al. 1998, Kintsch & Urban 2002); a recent study showed that a focal-species indicator approach maximized the capture of rare species while community-level and physical-proxy approaches performed much worse.

Policy consequences of choice of indicators

Caspian Richards, Macaulay Institute, UK

The thought-provoking post by Robin Moritz and Peter Bliss has interesting policy implications, in that if indicators focus on habitat quality rather than biodiversity, then presumably the legislative framework will need to do likewise. There is potentially a considerable difference between policies which reward those management practices which provide habitats seen to be of good quality (or penalise those which fail to provide it), and those which provide rewards based on the presence or absence of specific indicator species. The latter approach seems likely to lead to management for indicator species, rather than for the broader habitat; current approaches also highlight the difficulties associated with rewarding land managers for the presence of specific mobile species (this occurs in Scotland with geese and capercaillie, amongst others). Inevitably there are disputes about the timing and frequency of the monitoring on which rewards are based, the fact that practices elsewhere and beyond the control of land managers will determine their level of reward, and even sometimes competition between neighbours to attract the species in question from one property to the next just in time to be monitored (this has been known to occur with geese).

I am not sure whether monitoring habitat quality rather than biodiversity really does get round these difficulties (if we still use single indicator species - albeit perhaps different ones - then probably it does not), but it seemed like a useful framework for beginning to think about the consequences of basing policies on different kinds of indicators. In general it seems safe to say that if policies aim at changing land management practices through reward, punishment or a combination of both, then any changes will be directed to satisfying the letter of the law rather than the spirit of it, i.e. to addressing the performance indicators rather than the underlying reasons behind their selection. This makes it all the more important to choose indicators carefully, as otherwise the consequence may well be the opposite of that intended.

Research needs for Monitoring, Indicators and Reporting: Reflections on the first week and introduction to the second week of the e-conference

Allan Watt, Session chair, Centre for Ecology and Hydrology, Banchory, UK

Rob Tinch opened one of the other sessions of the e-conference with two quotations. Rather belatedly, I offer this quote, of clear relevance to monitoring biodiversity:
On yonder hill there stands a coo,
If it's no there, it's awa noo.
[William MacGonagall (coo, cow; awa, away; noo, now.)]
If only monitoring biodiversity was as simple as that.

There were six contributions to this session last week. Katalin Torok identified research needs for the monitoring of habitat extent, emphasising the need for research into optimal sampling frequency for each habitat type and the development of remote sensing methodologies at the necessary scales. Jan Jansen recommended research in comparing and evaluating all existing flora and vegetation monitoring projects in Europe, with the ultimate goal of creating a reliable, standardized, mutual compatible and pragmatic Pan-European monitoring system. He also called for more research into the optimisation of technical aids for fieldworkers, such as the use of palmtop computers for data entry, GIS technology, remote sensing and standardized data management programmes.

Paulo Sousa considered the problem of monitoring soil biodiversity. Although research has failed to identify any single taxonomic group as an indicator of the soil fauna, he reported some interesting research supporting the use of higher taxonomic units (genera and families) for indicating species diversity. On the issue of microbial diversity monitoring, Annick Wilmotte acknowledged the need for complete inventories and for the development of microbial indicators. However, these goals require research to develop techniques that are simple, fast, and cheap enough to be used routinely.

Frédéric Gosselin discussed some of the fundamental problems associated with indiactors and provided a detailed description of the research required in their development. Robin Moritz and Peter Bliss also provided a thought-provoking contribution on indicators, separating the development of indicators to measure habitat quality with those that measure biodiversity.

No contributions in the first week explicitly considered research needs for headline indicators designed to monitor the state of biodiversity in Europe. Four of these have recently been proposed (as outlined in the introduction to this session). These are listed again below, together with some possible research needs:

1. Trends in extent of selected biomes, ecosystems and habitats

Can research identify which biomes, ecosystems and habitats should be monitored? Or should all biomes, ecosystems and habitats be monitored? Are we able to monitor selected biomes, ecosystems and habitats? Can remote sensing effectively monitor biomes, ecosystems and habitats?

2. Trends in abundance and distribution of selected species

Similarly, can research identify which species should be monitored? Can these species be effectively monitored?

3. Change in status of threatened and/or protected species

Can threatened and/or protected species be accurately monitored and can such species be monitored without adding further risk to their status?

4. Trends in genetic diversity of domesticated animals, cultivated plants, and fish species of major socio-economic importance

Are methods available to monitor the genetic diversity of these species?

My personal view is that we know enough to be able to monitor biomes and habitats adequately at the European scale [Headline Indicator 1]. The major challenge is to quantify and monitor the quality of these habitats, or to ensure their "favourable conservation status" as the Habitats Directive puts it. This clearly falls outside the scope of this particular indicator

but the second indicator "Trends in abundance and distribution of selected species" could go some way to providing an assessment of habitat "quality" as long as the information on the selected species is habitat-based. Robin Moritz and Peter Bliss make useful suggestions about the development of indicators to assess habitat quality. There is then also the potential to put the information together in a Natural Capital Index, a system developed by Ben ten Brink (see contribution in a previous e-conference).

In developing methods to describe "Trends in abundance and distribution of selected species" [Headline Indicator 2], the main challenge is to find species whose abundance and distribution reflect general trends in biodiversity. Frédéric Gosselin dealt with this issues in some depth in his contribution and Paulo Sousa referred to the BioAssess project, which aimed to identify the best indicators amongst a range of groups of plant and animal taxa. This project involved research teams across Europe and other national projects have also provided valuable information on the relationships between the diversity of different taxa. Much more research is needed in this area if we are going to understand the relevance of the information gained by monitoring selected species.

Monitoring of "Change in status of threatened and/or protected species" [Headline Indicator 3] is probably best done by collating information on these species from those concerned with their conservation. IUCN will undoubtedly continue to play a major role here and initiatives such as the UK's Species Action Plans will improve our knowledge of trends in threatened species.

Presumably monitoring of the first two elements of "Trends in genetic diversity of domesticated animals, cultivated plants, and fish species of major socio-economic importance" [Headline Indicator 4] is relatively straightforward. I will leave the discussion of monitoring of genetic diversity of fish species to our sister e-conference MARBENA.

The strength of an e-conference is that its many contributors can share their combined concerns and expertise and I therefore look forward to your comments on these suggested research needs: we must urgently identify the research priorities for putting these indicators into action. Comments on monitoring the state of biodiversity are therefore still welcome.

In the second week of this session we will consider the research needed to ensure that we can adequately monitor the impact of single and multiple drivers of biodiversity. We will consider drivers that have had an impact on biodiversity for millennia, such as land use change, and drivers that are likely to have an increasing impact, such as the use of genetically modified crops. We will start by considering the difficult issue of separating the impact of natural and anthropogenic drivers of biodiversity.

Quantifying the separate impact of natural and anthropogenic drivers of biodiversity

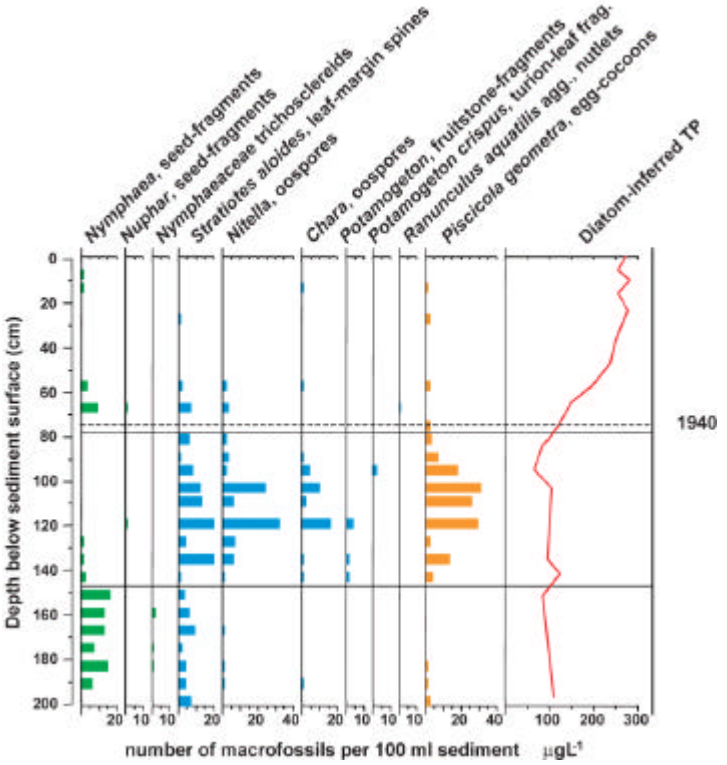
Richard Bradshaw and Peter Rasmussen, Environmental History Research Group, Copenhagen Geocentre, Denmark

SUMMARY: Linking existing ecosystem knowledge with high resolution, long-term data through modelling is an emerging research field that helps separate the natural and anthropogenic drivers of biodiversity and underpins the monitoring process.

There are three central tasks facing scientists who monitor biodiversity change: 1) identify significant changes in biodiversity, 2) quantify the role of anthropogenic influence on these changes, and 3) communicate the conclusions to decision-makers. While there is some existing research on the first two topics, it is weakly co-ordinated and results are only communicated outside of the research community in a haphazard manner.

1. Identification of biodiversity change can eventually be achieved through developing national monitoring programmes, but capitalisation of pre-existing monitoring schemes and linking direct observation with palaeoecological reconstruction provides important short-cuts and places current developments in a valuable temporal perspective. For example, macrophyte communities in Danish lakes have significantly altered during the last 100 years with a general loss of species as a result of eutrophication superimposed on longer-term natural succession (See figure 1).

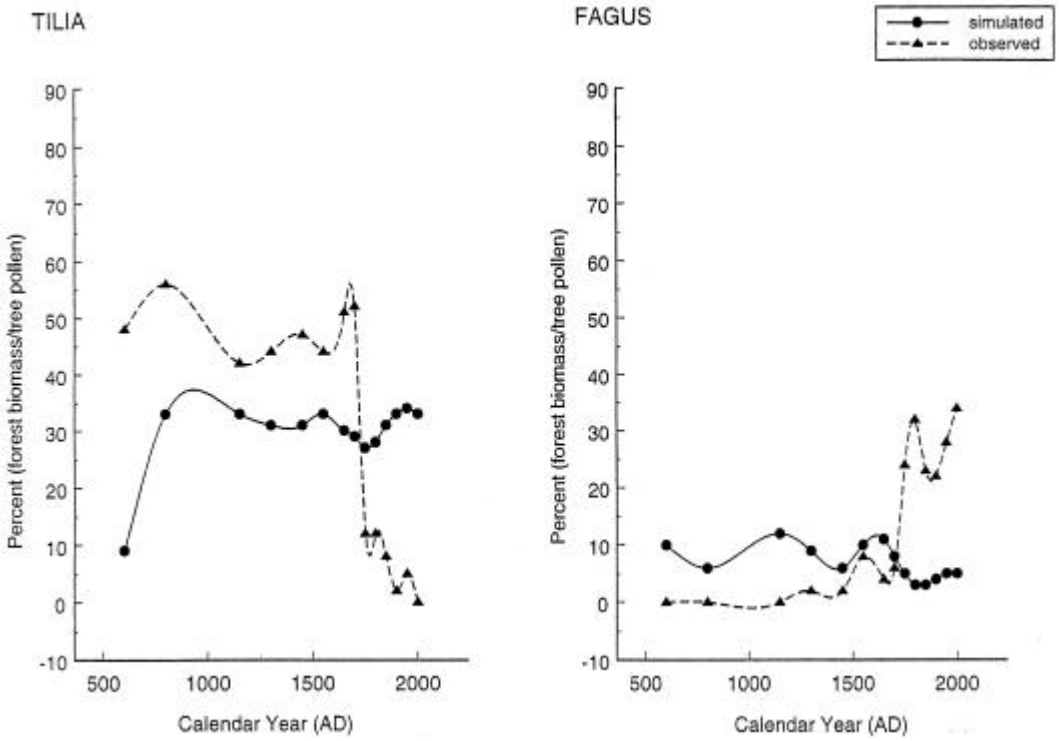
Figure 1. Selected plant and animal macrofossil remains and reconstructed total reconstructed phosphorus concentration (TP) for a lake in Denmark. The 1940 horizon is marked with a dashed line. Note the disappearance of most of the macrophytes after 1940 in association with increasing phosphorus pollution (P. Rasmussen & N.J. Anderson unpublished data). (Odgaard & Rasmussen, 2001).



Even 50 years of direct observation would have missed this important anthropogenic effect on biodiversity. More research is needed from other ecosystems that are indicators of environmental quality to link existing and new longer-term data to current observations.

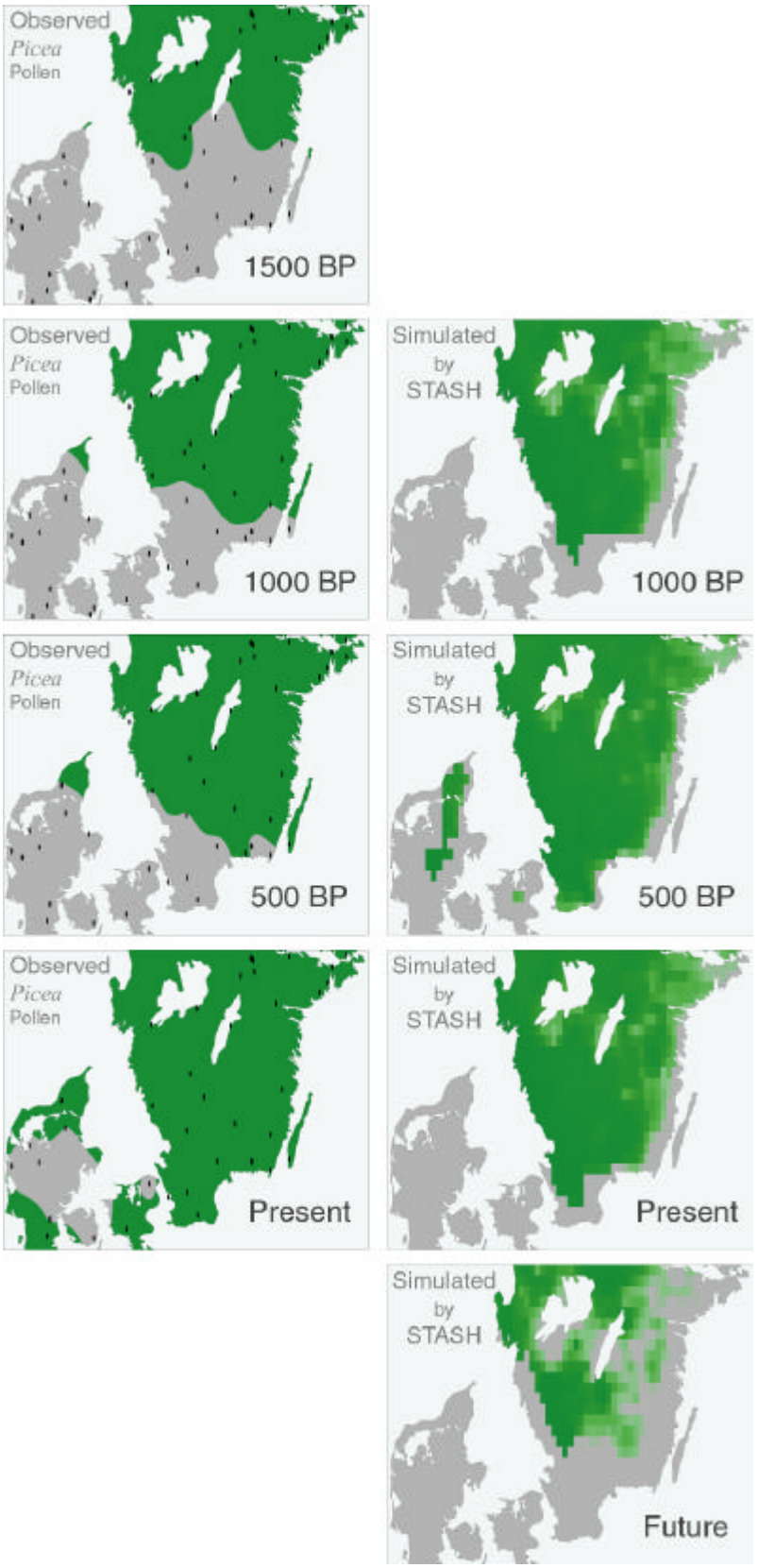
2. Biodiversity change is easily demonstrated, but it is a research challenge to understand the drivers of change and quantify the anthropogenic influence. The emerging field of dynamic ecosystem modelling can compare biodiversity predictions from model systems with long-term field datasets. In a Danish forest, the long-term replacement of species-rich Lime (*Tilia*) forest by species-poor Beech (*Fagus*) forest was shown to be driven by anthropogenic activity rather than climate change (See figure 2).

Figure 2. Palaeoforest data-model comparisons for Fagus and Tilia at Draved Skov, western Denmark. Simulated tree abundance data (closed circle line graph) is presented as percent forest biomass, which is defined as the percentage of species biomass relative to total forest biomass (Mg ha-1). Observed tree species abundance data (closed triangle line graph) is presented as percent pollen, with pollen data graphed as 50-year averages to match scales used for presenting biomass data.) (Cowling *et al.*, 2001).



Conversely the spread of Spruce (*Picea*) forest into southern Scandinavia is a climate-driven process, which has recently been accelerated by anthropogenic planting and adoption of industrial forestry techniques (See figure 3).

Figure 3. Observed and simulated Picea distributions during the last 1500 years. The observed distributions are reconstructed from fossil pollen data. The simulated distributions are generated by the bioclimatic model STASH. The predicted future distribution assumes an atmospheric CO2 composition twice that of present.) (Bradshaw *et al.*, 2000).



Linking models with long-term data is a promising research area that will increase understanding of ecosystem drivers, both natural and anthropogenic, which alter biodiversity.

3. Reporting biological monitoring through the scientific literature has little impact upon agencies responsible for biodiversity protection. Forums and ideas are needed to develop a better interface between scientists and decision makers that is effective and

respected by both communities. Research is needed to design this research-community interface and identify the people and roles necessary to improve the presently weak and haphazard bilateral exchange. Cross-cutting research is also needed to link knowledge about pristine, base-line conditions and early anthropogenic impact to appropriate protection and restoration goals in present-day, over-exploited ecosystems.

Research needs for monitoring the impact of land use change on biodiversity

Jari Niemela, Department of Ecology and Systematics, University of Helsinki, Finland

SUMMARY: Research is needed!

As space is limited, I only highlight a few of the most urgent research needs.

Before biodiversity monitoring is undertaken, (at least) the following questions must be addressed:

- What is the goal of the monitoring to be undertaken?
- What are the indicators to be used?
- How are the data collected and analysed?
- What are the threshold levels, and what actions are to be taken if thresholds are exceeded?
- How are the results going to be communicated to the various stakeholders?

All these components require research, but the amount and type of research differs between them. For instance, the goal may not need much additional research as we know that one of the prime goals of biodiversity monitoring in Europe is to assess whether halting the loss of biodiversity by 2010 is realised.

As monitoring biodiversity in its entirety is virtually impossible, research has focussed on developing indicators. However, there appears to be little consensus among scientists about 'whose bioindicator is best' (Andersen, 1999). Thus, further research into covariation among taxa, and the selection of taxa to be included in a 'shopping basket' of indicators is needed. Research on other types of indicators, e.g. impact indicators, such as degree of habitat fragmentation or hunting pressure, is equally important.

Research is needed to determine appropriate designs of monitoring programmes, data collection & analyses. What kind of data enables us to distinguish the effects of human-caused land-use changes on biodiversity from natural variation – if such exists anymore? The applicability of the BACI design to monitor biodiversity changes should be researched. To find out whether an impact (such as a forestry operation) has an effect on biodiversity monitoring should start before and continue after the impact both in Control sites and in the Impacted sites. A problem is the lack of unimpacted control (reference) sites in Europe.

Knowledge about temporal and spatial dynamics of populations helps to determine threshold levels. A further research question is what kind of actions are needed if thresholds are surpassed. For instance, to stop the decline of a species restoration of its destroyed habitats may be required. Therefore, research on restoration ecology is needed.

An additional research question is the interaction between biological indicators and socio-economic indicators. Communication of the monitoring results to the stakeholders may not require much research, but dedicated scientists are needed to maintain this interaction.

Finally, the question of the spatial scale of monitoring activities requires research attention. There is a fairly solid understanding about biodiversity changes at the local scale but research is needed to improve understanding of changes at landscape, regional and higher spatial scales, and to explore interactions between the scales. Furthermore, as biodiversity decline is a global issue, research and the consequent development of actions should be based on international collaboration.

Unifying strategies for monitoring biodiversity

José M. García del Barrio, CIFOR-INIA, Madrid, Spain

SUMMARY: Monitoring of biodiversity using indicators is needed for a realistic and cost effective strategy to stop biodiversity lost by 2010. Data integration of different sources (species and habitat distribution), in a territorial framework could be a feasible strategy for detecting changes at the landscape level and for evaluating local and regional environmental policies.

Indicators to monitor the state of biodiversity in Europe should be suitable at different scales for contrasting the efficiency of sustainable development strategies all around Europe. In this context, research has two main unresolved questions.

1. What are cost-effective strategies for monitoring biodiversity changes over time and space at different organization levels?

2. Are there synergies or correlations between biological indicators of biodiversity (species lists by biological groups) and other social or economical indicators?

The answer of these two questions implies a wide agreement in the basis of a European monitoring system that includes: Territorial scale, biological groups and organization levels.

Stakeholders and policy makers demand biodiversity data at a regional and national level. Biodiversity information, however, have to be related to land covers and land uses (which imply a local scale) to have an ecological meaning. As an example in the Spanish case, municipalities are the smaller administrative units with both social and economic meaningful data, which could be used for mapping land uses or land covers distribution at local or landscape scales. The land-uses or land cover maps obtained, would be the basis for habitats delineation. These habitats would be the units for biodiversity sampling of different biological groups. The sampling requires standard methods (no necessarily exhaustive) in order to compare over time and space.

Relationships between socio-economic variables and biodiversity indicators can be in the basis of biodiversity changes and could act as driving forces for populations and species assemblages at landscape level.

In order to define a network for monitoring biodiversity, existing facilities could be used (for example areas included in the Nature 2000 network). The use of a common network, and standard procedures could be extended to different objectives and topics (for example, genetic diversity of valuable species, population dynamic of endangered species, new assemblages of species due to global change, etc.).

If we were able to detect losses in biodiversity, could we reduce or invert the tendencies under a context of sustainable development? We need information on the relationship among social and natural value of biodiversity and which are the effects of different management models on biodiversity. This information could be used to implement policies at the regional scale to maintain or enhance biodiversity.

As a final remark, we would like to stress that it would be necessary to define a common network and methodological approaches, to escape from too local or too wide biodiversity analysis that could not be used for conservation, land planning and rural development activities.

Potential impacts of genetically modified organisms on biodiversity

Les Firbank, Lancaster Environment Centre, Centre for Ecology and Hydrology, UK

SUMMARY: Concerns over the potential impacts of genetically modified organisms on biodiversity have resulted in a range of scientific studies that are informing risk assessments of commercial releases. These include research into gene flow, invasiveness, trophic interactions and indirect effects of changes in crop management. Attention is now shifting to the requirements for monitoring commercial releases. Directive 2001.18/EC requires that any such releases are monitored, in order to identify interactions of the GMO with non-target organisms, taking into account both anticipated and unanticipated effects. Monitoring is expected to include both case-specific monitoring and more general surveillance.

If the risk assessment has been undertaken thoroughly, the need to monitor anticipated effects is surely low. If adverse effects had been expected, then the crop should not have received clearance in the first place. The main target of monitoring is perhaps to ensure that the conditions that were assumed within the risk assessment are not changing, especially the way any GM crops are being managed by the farmers – and this can be monitored using farmers' records and more general surveillance. Research needs are few; impacts on soil biota may be an exception.

The design of appropriate surveillance systems is more challenging. It's clearly not feasible to survey absolutely everything in the agro-ecosystem. Surveillance should be able to detect emerging problems – not simply temporary or localized change. These problems can only be judged properly at larger scales than we are used to in risk assessments. Thus, the mere presence of wild relatives with a GM construct is not a problem in itself, otherwise commercial release should have been prevented. However, signs that a population of such plants is increasing and becoming invasive *do* need to be detected. Likewise, while temporary and localized changes in populations of food plants for birds should not be of concern, any larger scale downward trends in such species should be detected quickly. Also, the causes of these trends needs to be identified – there are many factors that cause large scale shifts in farmland biodiversity other than GM cropping.

The major need for research is to devise surveillance systems that are sensitive, timely and cost-effective. The systems need to detect trends in selected biodiversity indicators at whole farm and landscape scales. In order to assign cause to effect, the systems need to survey the ways that the crops are being managed. Also, there needs to be control data from comparable non-GM systems. As long as the GM crops are rare, the wider landscape can be used as a comparator. However, if GM crops become more widespread, then realistic comparisons with the non-GM situation become much harder without advanced modelling techniques.

Research must encompass issues of informatics and governance, to maximize the use of data that are already being collected for other purposes. Research is also needed to design systems that have the confidence of the public. But the greatest challenge is to devise methods of assessing biodiversity indicators across European landscapes in sufficient detail that both adverse trends and their likely causes can be identified quickly enough for effective action.

RE: Potential impacts of genetically modified organisms on biodiversity

Rehema White, Centre for Ecology and Hydrology, Banchory, UK

In belated response to the article by Les Firbank (22/4/04) I would like to add a further research area to assess the potential impacts of genetically modified organisms on biodiversity. Longer term studies on the release and commercial use of GMOs in developing

countries (especially recently in South America) have demonstrated unpredicted and negative effects on biodiversity due to the actions of he farmer combined with the biological properties of the plants. I would argue that an interdisciplinary approach to predict the impacts of GMOs is required, in which ecologists measure biological effects (as Les Firbank describes) and social scientists assess the attitudes, understanding and potential actions of farmers and other stakeholders. The interdisciplinary team can then combine notes and provide a more realistic long term picture of the likely impacts on biodiversity.

Developing indicators to assess the impact of anthropogenic drivers on biodiversity: How can we conceptualise land use intensity in agricultural landscapes?

Norbert Sauberer, Federal Environment Agency, Austria

SUMMARY: Despite the progress in delineating key factors and processes which have a major influence on farmland biodiversity, more research needs to be done in developing cost-effective indicators.

The negative influence of increasing land use intensity on biodiversity in farmland is well documented (e.g. Donald et al. 2001). Agricultural intensification homogenises the landscapes and leads to a loss of ecological heterogeneity, spatially and temporally (Benton et al. 2003). Nevertheless, species richness depends on a significant proportion of semi-natural habitats and keystone structures embedded in the matrix of intensively used fields or meadows (Steffan-Dewenter et al. 2002, Duelli & Obrist 2003, Tews et al. 2004).

On the other side, traditional farming "produced" a species-rich mosaic of habitats (Duelli 1997) in many regions and a total abandonment of agriculture can have an undesired negative impact on the diversity of some organism groups, at least at the landscape scale (Purtauf et al. 2001). Generally, habitat fragmentation can have negative and positive effects on biodiversity (Fahrig 2003). So, some level of land use intensity seems to correlate positively with high species richness in agricultural landscapes. But how to measure land use intensity quickly and with reasonable costs?

In an empirical study in eastern Austria a group of ecologists tested several methods to measure land use intensity and its influence on species richness at the landscape-scale. The approaches included measurements in the field (Zechmeister & Moser 2001) and combinations of remote sensing techniques and ground truthing (Moser et al. 2002, Haberl et al. 2004). It was demonstrated that all proposed methods of measurement are useful in general, but it remained unclear if the results can be translated to other agricultural landscapes. Also the different methods need to be compared in more detail with respect to their costs and effectiveness.

Although all eight taxa investigated in the Austrian study responded negatively to increased land use intensity, there are obvious differences in their sensibility. While gastropods and bryophytes react extremely sensible to increasing land use intensity, carabid beetles occurred with considerable species richness in quite intensively cultivated areas (cf. Sauberer et al. 2004, Zulka et al. in preparation). So, additional research should be done to investigate and compare the influence of land use intensity on various organism groups.

RE: Developing indicators to assess the impact of anthropogenic drivers on biodiversity: How can we conceptualise land use intensity in agricultural landscapes?

Felix Herzog, Swiss Federal Research Station for Agroecology and Agriculture, Zurich, Switzerland

I find it helpful, especially in the context of biodiversity and habitats, to differentiate between:
1.) Land-use intensity in terms of output (or input) per hectare. Examples of land-use indicators are yield (kg/ha), nitrogen fertilisation (kg/ha), pesticide application, etc.

2.) Landscape diversity and structure. Examples of landscape indicators are the share of non-productive areas (%), the connectedness of non-productive areas (average distance).

Agricultural development in the second half of the 20th century changed both components. They are not completely independent but they are independent to some extend. You may find very intensively managed agricultural fields in a fine-grained landscape (e.g. countries of the former Western European bloc states such as Belgium, Switzerland) and

rather extensively managed fields in a coarse grained landscape (e.g. some countries of the former Eastern European bloc states, e.g. Czech republic, former Eastern Germany).

If we keep the two factors (intensity, landscape structure) apart, we preserve the information about two different driving forces, which are - at least partly - controlled by different actors (farmers mainly influence intensity as defined above, policy makers have more influence on landscape structure).

Research needs for Monitoring, Indicators and Reporting: Reflections on the second week and introduction to the third week of the e-conference

Allan Watt, Session chair, Centre for Ecology and Hydrology, Banchory, UK

Two contributions at the start of the second week of the e-conference focussed on issues relating to monitoring the state of biodiversity. Felix Herzog mentioned recent research on a methodology for consistent monitoring of habitat information across Europe. Caspian Richards considered the policy implications of legislation supporting either the monitoring habitat quality or of specific indicator species, specifically where land managers are rewarded. He pointed out that the presence of an indicator species in a particular area in also dependent on the actions of the others and that, because land managers are likely to manage their land to maximise the benefits accruing from monitoring-linked payments or fines, monitoring of habitat quality is potentially better than monitoring indicator species. I find the lack of contributions to this topic very encouraging – presumably we need very little research into monitoring the state of biodiversity and can get on with the job of doing so immediately.

We spray the fields and scatter
The poison on the ground
So that no wicked wild flowers
Upon our farm be found.
[From Harvest Hymn by John Betjeman]

In the second week of the e-conference, five contributions considered monitoring the impact of anthropogenic drivers of biodiversity. Richard Bradshaw and Peter Rasmussen started the discussion in a contribution on quantifying the separate impact of natural and anthropogenic drivers of biodiversity. They started their contribution by arguing for the need to link monitoring programmes with palaeoecological reconstruction to put currently observed trends in biodiversity in perspective – in other words, to detect significant changes in biodiversity. They also gave examples of using palaeoecological reconstruction and modelling to identify the causes of biodiversity change. Their concluding points are so important that I will include them verbatim: "Reporting biological monitoring through the scientific literature has little impact upon agencies responsible for biodiversity protection. Forums and ideas are needed to develop a better interface between scientists and decision makers that is effective and respected by both communities. Research is needed to design this research-community interface and identify the people and roles necessary to improve the presently weak and haphazard bilateral exchange. Cross-cutting research is also needed to link knowledge about pristine, base-line conditions and early anthropogenic impact to appropriate protection and restoration goals in present-day, over-exploited ecosystems."

Jari Niemela followed with an equally direct contribution on the need for research on monitoring the impact of land use change on biodiversity. He started by pointing out the need to prioritise research, focussing on the most important needs. As with the previous contribution, he asked the key question: "What kind of data enables us to distinguish the effects of human-caused land-use changes on biodiversity from natural variation? Perhaps this is the major challenge for detecting the impacts of all types of anthropogenic change.

Norbert Sauberer also considered this challenge in relation to land use change. He summarised recent research on the impact of agricultural land use intensity on biodiversity and on attempts to use this knowledge to develop indicators of biodiversity based on land use intensity. He reports some success in doing so but points out that different groups of plants and animals appear to respond differently to measures of land use intensity.

Les Firbank considered monitoring and the potential impacts of genetically modified organisms on biodiversity. As commercial releases of genetically modified crops become more likely, Directive 2001.18/EC requires these releases are monitored to detect impacts on non-target organisms. Les Firbank also considered the more challenging need to design surveillance systems that are sensitive, timely and cost-effective.

José M. García del Barrio discussed several aspects of monitoring biodiversity including research into the design of monitoring networks. He stressed the need for a common monitoring network with standardised monitoring procedures.

The contributors to this part of the e-conference also made some important general points. Richard Bradshaw and Peter Rasmussen, and Jari Niemela emphasised the need for international collaboration amongst scientists to address research on monitoring biodiversity and both they and Les Firbank argued for the involvement of scientists in the communication of monitoring results to stakeholders – as Les Firbank pointed out, we need monitoring systems that have the confidence of the public. Les Firbank and Jari Niemela also strongly emphasised the link to need to link monitoring to action.

I found these contributions much less encouraging than the contributions on monitoring the state of biodiversity. In fact, I wonder if we will ever be able to monitor accurately the effects of single anthropogenic drivers of biodiversity. Much more research on the impacts of single and multiple drivers of biodiversity is needed, partly field-based, partly based on palaeoecological information and partly through models incorporating the knowledge gained in other studies. None of these approaches is any more important than any other but there is an urgent need to establish more coordinated, international field-based studies, of the type that the contributors to this session argued for, carefully designed to extract information on the impact of one or more of the major anthropogenic drivers of biodiversity. I also strongly recommend the linking of these studies to the international monitoring effort to monitor the state of biodiversity.

The European Biodiversity Strategy, the European Biodiversity Action Plans, the Birds and Habitats Directives, Natura 2000 and agri-envionment schemes have been a part of a significant European response to biodiversity loss. At the national scale, there is governmental and non-governmental action to halt biodiversity loss, including Species and Habitat Action Plans, Local Action Plans and National Action Plans for biodiversity. At the global scale, the Convention on Biological Diversity has been in operation for over ten years and many NGOs have been in action for much longer. But do we know if this response is having an impact on biodiversity loss and, if not, what research do we need to enable us to monitor the impact of the many policy and practical responses?

Do species and habitat action plans really work?

Michael Usher, Stirling University, UK

SUMMARY: Monitoring is essential, but there are research questions associated with most stages of its planning, implementation and analysis.

Following the Convention on Biological Diversity, many species action plans (SAPs) and habitat action plans (HAPs) have been written for what are regarded as priorities. As I look at these plans, I find it incredible that so many of the priorities are charismatic - birds, mammals, orchids, butterflies, or sea-grass beds - whereas so often non-vascular plants and invertebrates are forgotten. This points to a research need: more information about the less charismatic aspects of biodiversity is needed so that more balanced priority lists can be drawn up. Are we missing important keystone species or vital habitats such as soil?

Many communities of people want monitoring. Activists want it to demonstrate that insufficient is being done, i.e. 'bad news' stories. Bureaucrats want it to demonstrate what a good job is being done, i.e. 'good news' stories. And scientists want it because they are interested in the dynamics of particular habitat or species. There are therefore a number of communities who want monitoring for very different reasons, and this has implications for research. Where do we begin?

First, there is the question of a baseline. If the SAP or HAP was chosen on the basis of good criteria, then baseline data probably exist. If there is no good baseline, a small research project might be needed to ensure that there are reliable data from which to determine trends.

Second, what should be monitored? Not everything can be monitored, so only a few aspects of the SAP or HAP have to be chosen. Does this require research to ascertain what is most appropriate, and what might make a good indicator for one plan or for a group of plans? Third, can the costs be kept in reasonable proportion to the costs of the whole action plan? This is an area for considerable research, exploring more cost-effective methods that are at least as accurate as older methods. The methodology of monitoring is continually changing, but new methods do need to 'map' onto existing methods so that there is continuity of trend information.

Fourth, it is possible that no research is required to determine the frequency of monitoring. All too often it is assumed that monitoring will be done annually, but this might not be necessary. For habitats, decadally might be appropriate, but a small research project might be needed to ensure that this is satisfactory.

Once monitoring has started, there are many aspects that might come under the heading of 'research' – collecting the data, verifying them, storing them, analysing them, and then writing reports. Can all of this be done in ways that do not bias the outcome of the monitoring? Can the results determine whether the action plan is having an effect on biodiversity? An aspect of research will be the recognition of the 'signal' due to the action plan from the 'signals' due to other changes, in climate, ecological succession, land-use change, species' population dynamics, etc. Does anyone know ways to separate these signals?

Using soil and surface macrofauna groups as surrogates for grassland biodiversity

Catherine Souty-Grosset, Poitiers University, France; France; **Isabelle Badenhausser**, INRA, France; **Julian Reynolds** , Trinity College, University of Dublin, Ireland.

SUMMARY: Macroinvertebrate guilds may be useful surrogates for grassland biodiversity, allowing evaluation of their status (naturalness, persistence, recovery over time).

Each strand of this e-conference provides information of importance to other strands, and here we attempt to integrate some ideas on biodiversity in grassland agricultural systems. Grassland biodiversity is a feature of time; after disturbance, natural or human-induced, it may take considerable time for natural communities to re-establish themselves (probably centuries in alpine areas, according to Christoph Scheidegger). Macro-vegetation does not bear a close relationship with faunal diversity; for instance, in fallow land rich in casuals the soil fauna may be poor and unstructured. There are many groups of soil invertebrates (differing in size and complexity). However, Paulo Sousa provided a thoughtful summary of the usefulness of surrogate groups among soil fauna, and Robin Moritz indicated that macro-invertebrate surrogates have considerable potential as indicators of the biodiversity potential of grassland habitats. The related Conference strand on Monitoring, Indicators and Reporting shows that there is little consensus on the most appropriate indicators of biodiversity (e.g. Jari Niemela). Keystone species are not widespread among grassland invertebrates, herbivory inducing most top-down habitat changes. In investigating biodiversity of grasslands we have used two indicator surrogate macroinvertebrate groups; grasshoppers - herbivores active by day, and isopod woodlice - detritivores active by night. We established species distribution patterns for different natural grasslands in Ireland and developed sampling strategies to test community recovery and biodiversity of cultivated grassland plots of different ages in Ireland and Western France (Reynolds *et al.*, 2004). These would come into the context of arable systems as discussed by Dan Chamberlain (BAP Agriculture) and help to integrate knowledge on pastoral and arable grasslands, and on the influence of management on the grassland fauna (Curry, 1994).

Following ploughing and reseeding, most soil surface macroinvertebrates must recolonise from adjacent areas. In some long established grassland plots, species associations within the grassland came to resemble those in the boundaries (Johnson, 1989). The findings, in particular of the importance of permanent ecological corridors such as hedgerows and ditches in providing a permanent pattern in the mosaic of intensively farmed, fine-grained landscapes, should help in developing guidelines and strategies for conservation management (Berggren et al., 2002) and effective restoration methodologies (a link to the inputs of Katalin Torok, BAP-NR). The size and botanical structure of hedgerows may be less important than their history and relative permanence.

We would advocate the use of macroinvertebrate guilds composed of relatively few species as an approach to understanding the biodiversity of perennial grasslands, and as a key to their biodiversity and heritage value.

Assessment of freshwater biodiversity

Andrew Terry, IUCN

This is just a quick note to propose sources of data for monitoring freshwater biodiversity. As sectoral indicators are being devised, it important to constantly bear in mind their feasibility and where the data will come from. The impacts of human activities on freshwater ecosystems are quite well monitored with a set of physical, chemical and biological tools, which have been used for quite a long time in most EU countries. Even though these tools are not intended to provide quantitative information on biodiversity as such, they can provide an indirect assessment of biodiversity loss (or improvement), which could be used as a good indicator for the 2010 target. There will have to be amount of work done to determine just how well this data could act as an indicator for freshwater biodiversity. But given that it is already being collected for other reporting obligations - it would make sense to utilise it.

RE: Assessment of freshwater biodiversity

Julian Reynolds, Trinity College, University of Dublin, Ireland and **Catherine Souty-Grosset**, University of Poitiers, France

Andrew Terry is quite right to signal the potential value of freshwater invertebrate data, which is collected for water quality monitoring purposes across Europe. As with soil biologists, many freshwater biologists also have their 'pet' groups, in particular the ephemeropteran and plecopteran nymphs, which in most cases indicate good levels of dissolved oxygen and the larvae of chironomids, which span the whole range of freshwater types. The literature on such groups is very detailed.

Discussions on the value of freshwater crayfish as surrogate species for biodiversity took place this year under the auspices of CRAYNET and are due to be published in BFPP (Bulletin Français de la Pêche et de la Pisciculture) later this year. These large, active, long-lived invertebrates regularly turn up in monitoring samples and, while not strictly speaking indicators of highest water quality, are recognised as heritage species in many countries. In addition, they act as keystone species, thus able to regulate community biodiversity in streams and lakes. CRAYNET was set up as a network of researchers and managers to develop knowledge-based management strategies and a common European approach to management. We aimed to highlight and stimulate research activities into the three threatened crayfish species native to the European Community, and to disseminate findings on these heritage species to the wider public.

In the context of biodiversity, a significant round-table discussion is in press (Gherardi et al.,). Another important outcome is the recognition of species complexes within the white clawed crayfish, called, variously, Austropotamobius pallipes, A. lusitanicus and A. italicus. To the north, the taxon is clear, but further south, there are subspecies and perhaps sibling species to consider. We do not yet know the various ecological tolerances of the different taxa, and consequently, assumptions about their value as bioindicators of water quality cannot be sustained across the range without further research. Implications for the recently adopted Water Framework Directive, which aims at having good quality surface water across whole catchments regardless of national borders, include our current thinking that crayfish are indeed surrogate species or heritage species, rather than narrow band water quality bioindicators. Education is of paramount importance, and so we are concentrating on this through our website, through a discussion forum reaching some 500 correspondents, and through the preparation of educational materials ranging from the Atlas to information leaflets for the public.

Guidelines for managers and other stakeholders are in preparation, and an Atlas of crayfish distribution in Europe, to be completed under the auspices of the Museum Nationale d'Histoire Naturelle in Paris. To this end we have started to create a large biogeographical

database, which will increase in value and usefulness with time. If the biodiversity implications of Goteborg are to be realised by 2010, a database such as this should not end with Craynet in 2005. To find out more: http://labo.univ-poitiers.fr/craynet/

Detecting changes in the impact of drivers and responses in freshwater habitats

Richard Johnson, Department of Environmental Assessment, Swedish University of Agricultural Sciences, Sweden

SUMMARY: The author highlights a number of research needs for detecting changes in the impact of drivers and responses in freshwater habitats. These include testing how well metrics developed for diagnostic/bioassessment purposes are correlated with other aspects of biodiversity; research into how ecosystem services are related to diversity, and how ecosystem resilience or resistance to stress is related to functionally important species; research looking at how representative different taxonomic groups in future European aquatic monitoring programs are of other elements of ecosystem biodiversity; research into the relation between habitat heterogeneity and species diversity. He also stresses the importance of providing sufficient taxonomic incentives.

Background - what we have or will have:

Aquatic ecosystems are among the most threatened habitats on earth, and across Europe many organism groups have become locally extinct due to human-induced changes in surface water quality. Although the type and severity of human-induced stress on ecosystem structure and function differs across Europe (e.g. Stanners and Bourdeau, 1995), three pan-European problems are nutrient enrichment (from agriculture and/or organic pollution), physical disturbance (e.g. alterations in hydrology) and toxicity (e.g. trace metals, pesticides and acidification). Cognisant of the widespread problem regarding the loss of biodiversity and other services provided by aquatic ecosystems, the European Community recently passed the Water Framework Directive (European Commission, 2000). In contrast to earlier legislation, this Directive is probably the most significant piece of ordinance to be assembled in the interests of preserving and restoring the biodiversity of inland waters, wetlands and coastal areas. A key feature of the Directive is its focus on detecting ecological change (i.e. degradation and recovery) and determining what human-generated pressures (or stressors) are acting as drivers of change. To accomplish this the Directive recognises that present and future pressures may dictate different monitoring and assessment designs such as surveillance, operative and investigative monitoring of ecological quality. The Directive is also innovative in that it acknowledges that ecosystem degradation is complex, occurring at different biological levels over different time scales, and to partly address this complexity the Directive recommends that multiple taxonomic groups (fish, macroinvertebrates, phytoplankton, phytobenthos and macrophytes) are to be used in national monitoring programs.

Internationally, activities are being implemented to monitor and restore the global biodiversity. For example, a work program has been proposed to establish and maintain by 2010 a comprehensive, cost-effective and ecologically representative global system of networks of protected areas to reduce biological diversity loss at the international, regional, national and sub-national levels (UNEP/CBD/COP/7/4). It has also been recommended that by 2015 all protected areas should be integrated into ecological networks and relevant sectors so as to maintain, and restore where needed, the ecological integrity or connectivity (e.g. land-aquatic and aquatic-aquatic connections, buffer zones and corridors) which is a prerequisite for ecosystem structure and function. International efforts are also focused on designing and implementing long-term monitoring programs to assess and monitor in protected areas (e.g. Nature 2000 areas) the status and trends in biodiversity. Here focus is on developing robust indicators of biodiversity to ascertain if/when change occurs, as well as identifying what drivers are responsible so as to be able to implement cost-effective management programs. Indeed, by 2008 standards, criteria and best practices for planning, selecting, establishing, managing and governance of national and regional systems of protected areas are to be developed and adopted, and by 2010 these monitoring programs should be implemented (UNEP/CBD/COP/7/4).

Research needs in relation to monitoring:

Given the two ambitious environmental initiatives mentioned above, namely the focus of the European Water Framework Directive on the use of multiple taxonomic groups in monitoring and assessment programs, and the underlying focal point of international (CBD) efforts on developing indicators and restoring and maintaining ecological connectivity, the future outlook for understanding natural and human-induced changes in biodiversity looks promising. However, to meet these ambitious objectives more knowledge is needed in a number of research areas.

Biodiversity indicators:

As explicitly stated in the CBD work program, biodiversity indicators need to be developed. However, due to spatially patchy distribution and/or low population densities, effective sampling of rare taxa is often difficult. Accordingly, alternative approaches need to be developed for monitoring biodiversity. Given the plethora of metrics developed over the last few decades for assessing the ecological quality of aquatic ecosystems, efforts should be devoted to determining if these metrics can be used to monitor changes in biodiversity. Here focus should be placed on testing how well metrics developed for diagnostic/bioassessment purposes are correlated with other aspects of biodiversity (such as the presence/absence of rare taxa). For example, the presence of red-listed stream macroinvertebrate species has been shown to be correlated with a pollution-specific metric developed in Denmark for assessing the effects of organic pollution on stream macroinvertebrate communities (Skriver, 1999). Another area that shows promise is the use of modelling approaches that utilize ecological relationships to predict community composition in the absence of human-induced stress (e.g. Boon, 2000). Regardless of the approach(es) used, we need to validate (e.g. statistical power estimates) the methods to be confident that if degradation is occurring that it will be detected (i.e. low false negative errors).

Besides developing indicator metrics or approaches, we also need to better understand the role between diversity, ecosystem function and the services provided by aquatic ecosystems. Certain organism groups may, for example, play key roles in ecosystem function. How ecosystem services are related to diversity, and how ecosystem resilience or resistance to stress is related to functionally important species are two important questions that need to be addressed.

Use of multiple taxonomic groups in monitoring and assessment of changes in biodiversity:

As mentioned, one of the innovative aspects of the WFD is the recommended use of different taxonomic groups in future European aquatic monitoring programs. These data should greatly improve our understanding of changes occurring in stressed ecosystems, but also provide high quality data and information on geographic patterns and trends in biodiversity for a number of organism groups across a number of minimally disturbed (or relatively pristine) habitat types. However, the question as to how representative these organism groups are of other elements of ecosystem biodiversity still needs to be resolved. Along these lines, one interesting new approach is the use of Co-Correspondence Analysis (ter Braak and Schaffers, 2004) to better understand the relationships between multiple organism groups.

Ecosystem connectivity and biodiversity:

In the highly managed landscapes of much of Europe landscape fragmentation (deterioration of habitat configuration) and simplification (loss of habitat diversity) have resulted in lower habitat heterogeneity and subsequently loss of biodiversity. To successfully restore the natural structural and functional integrity of an ecosystem often requires knowledge of the relation between habitat heterogeneity and species diversity. Present-day concepts on the importance of land-aquatic and aquatic-aquatic interactions are poorly developed, and more basic knowledge is needed to quantify the importance of linkages between habitat or ecosystem types. The importance of ecosystem connectivity is particularly relevant to better design and implement cost-effective restoration projects with stakeholder involvement. Finally, if cause-and-effect relationships can be identified between habitat and

species diversity, then we need to pursue the use of GIS-type data to develop cost-effective methods for monitoring potential broad-scale changes in diversity.

The need for taxonomic incentives:

Good taxonomy underpins good estimates of diversity, yet my guess is that given the relatively low priority on educating taxonomists, we are getting alarmingly close to the point where taxonomic knowledge is going locally extinct at a faster rate than species!

Monitoring the impact of agri-environment schemes

David Kleijn, Nature Conservation and Plant Ecology Group, Wageningen University, Wageningen, The Netherlands

SUMMARY: We need to link population trends of biodiversity or indicators to the drivers of biodiversity and the impacts of policy responses such as agri-environment schemes. In the field the effects of these two types of factors are difficult to separate. We need to know urgently what environmental factors may act as ecological constraints to biodiversity enhancement and how these may interact with the effects of policy responses.

As Allan Watt states in his opening statement of this part of the e-conference we need to consider the research needed to ensure that we can adequately monitor 1) changes in the state of biodiversity, 2) the impact of single and multiple drivers of biodiversity and 3) the impact of policy responses to biodiversity loss, particularly the measures included in the BAPs, the overall impact of the Strategy and the 2010 target to halt biodiversity loss.

This means that we not only need to know how biodiversity is changing, we also need to know what causes the change. Knowing what causes the change is crucial because only then will we be able to take effective measures against any measured biodiversity decline. We need to link population trends of biodiversity or indicators to the drivers of biodiversity and the impacts of policy responses. In the field the effects of the two factors are difficult to separate and this inherent difficulty of monitoring studies needs more research urgently.

To illustrate this let me discuss some results of studies that monitor the impact of agri-environment schemes. The most effective approach to monitor the ecological effects of agri-environment schemes is to select pairs of similar fields, one with and one without a scheme. Subsequently determine the situation just prior to the start of the scheme and then follow population trends on the paired fields through time. A more positive trend on scheme fields will then indicate that the scheme was effective (Kleijn & Sutherland 2003).

But does lack of any difference in trends between the two field types indicate that the scheme has no effect, or that other factors have a stronger effect? In The Netherlands, agri-environment schemes aimed to enhance wader birds do not have a positive effect on settlement densities of the target species (Kleijn et al. 2001) despite the fact that reproductive rate is significantly enhanced on scheme fields (Beintema & Müskens 1987). It is unknown what happens with the higher number of chicks that are being produced on scheme fields.
Another problem is that higher densities on scheme fields cannot always be contributed to the effects of schemes. Kleijn & van Zuijlen (2004) observed higher settlement densities of waders on scheme fields in the Dutch province of Zeeland. The difference was already there at the start of the scheme, however, and proved to be largely correlated to the higher groundwater level of scheme fields.

We need to know what factors act as ecological constraints, that is, act as the primary factor that limits the abundance or species richness of the studied taxa. Policy responses to biodiversity loss, such as agri-environment schemes, are useless when they are implemented in areas where factors, other than farming practices act as ecological constraints. Furthermore we need to know what environmental factors interact with the effects of policy responses. The factors that most likely act as ecological constraints are abiotic factors, landscape context, diaspore availability and multitrophic interactions. Insights in these ecological constraints and their interactions with the effects of policy responses are currently missing. Without these insights we may be able to monitor trends in indicator or target taxa, but we won't know what it means.

The quest for the national biodiversity indicators

David Vackar, Agency for Nature Conservation and Landscape Protection of the Czech Republic

SUMMARY: Biodiversity is a prerequisite for the sustainable flow of ecosystem services and for the conservation of nations' ecological capital. Many international fora and processes struggle to push biodiversity indicators high on the agenda, inter alia Convention on Biological Diversity, European Commission and EEA or the Pan-European Biodiversity and Landscape Diversity Strategy. However, there are still research needs that have to be addressed to develop sound biodiversity indicators. Biodiversity indicators should be developed according to the scientific criteria but also in regard to the aim of simplifying complex information into a clear message about national and European biodiversity trends.

There were only a few attempts to develop a technical list of biodiversity indicators (Reid et al. 1993). The effort has been streamlined by the CBD and its scientific body (UNEP/CBD/SBSTTA/9/INF/7) and by the proposals for the structural, headline and core set of biodiversity indicators made by EC and EEA. At the Joint Meeting on biodiversity indicators and monitoring in Copenhagen last week (21-23 April), there was quite good consensus that the elaboration and implementation of the CBD state indicators (Group A) is of primary concern. Technical guidelines for the construction and monitoring of indicators therefore should be developed at the European level, to promote also developments of biodiversity indicators at national levels.

National biodiversity indicators based on the agreed set of biodiversity indicators should be developed as a basis for biodiversity accounting and assessment at the European level. This set of indicators should also include indicators according to the requirements of other biodiversity-related conventions at the Pan-European level (inter alia Bern, Bonn and Ramsar Conventions). For the EU region, indicator set should also meet the requirements of "Habitats Directive" on monitoring and reporting, as well as other biodiversity-related legislation (e.g. Water Framework Directive or Rural Development Regulation). Therefore intensive cooperative effort is required at the European level, which has been already set up at the Copenhagen Joint Meeting. Many states have already launched national biodiversity indicator and monitoring activities, including the Czech Republic.

To be usable at the national as well as international level, biodiversity indicators have to be based on standard monitoring methods that samples nations' biodiversity in a representative way. Further research needs also include the methods of aggregation and weighting for dealing with complex biodiversity data. Research concerning links between drivers, threats, state and responses would be also of critical importance, as well as research on ecosystem integrity and ecological health of different habitat types.

Research needs for Monitoring, Indicators and Reporting: Reflections on the third week of the e-conference and preliminary conclusions

Allan Watt, Session chair, Centre for Ecology and Hydrology, Banchory, UK

Contributions to the third week of the e-conference included comments on all three areas introduced at the start of this session of the e-conference: 1) monitoring changes in the state of biodiversity, 2) monitoring the impact of single and multiple drivers of biodiversity and 3) monitoring the impact of policy responses to biodiversity loss, particularly the measures included in the BAPs, the overall impact of the Strategy and the 2010 target to halt biodiversity loss.

Alan Feest and Kajetan Perzanowski argued for the standardisation of sampling methods used to monitor biodiversity. I am sure that most people will agree with this goal but Klaus Henle injected a note of pragmatism in reminding us that many different protocols are currently in use. Both he and David Vackar argued for the need to develop means to take advantage of the information coming from the use of different monitoring methods. In another pragmatic contribution, Andrew Terry pointed out that there is already considerable monitoring of the quality of freshwater ecosystems and suggested that it might be used in monitoring freshwater biodiversity. In another contribution on freshwater biodiversity, Julian Reynolds and Catherine Souty-Grosset discussed the use of freshwater crayfish as surrogate species. These authors and Isabelle Badenhausser also argued for the use of macro-invertebrates in monitoring grassland ecosystems. However, Richard Johnson expressed caution in the use of single taxonomic groups in monitoring biodiversity and pointed out that the Water Framework Directive recommends the monitoring of multiple taxa. Michael Usher highlighted the need for baselines in monitoring biodiversity and reminded us of the requirement for cost-effective monitoring, giving as an example the need for research to determine the frequency of sampling. Katalin Torok returned to the issue of monitoring habitat quality and gave one example of the assessment of habitat naturalness.

Last week I asked what research we needed to enable us to monitor the impact of the many policy and practical responses to biodiversity loss. Michael Usher, David Kleijn and Richard Johnson wrote perceptive contributions on this issue. Michael Usher asked if we knew enough to be able to separate the effects of Biodiversity Action Plans from climate change, land use change, natural dynamics of species etc. David Kleijn discussed the problem of evaluating the impact on biodiversity of agri-environmental measures. Richard Johnson discussed the Water Framework Directive, pointing out that one of its main features is to determine what human-generated pressures are acting as drivers of change.

Background to conclusions:

Considerable steps towards the implementation of biodiversity have recently been made at the global (CBD), pan-European (PEBLDS) and European Union scales. For the latter, 15 indicators have been proposed, five for immediate implementation in "Group A: Status and trends of the components of biological diversity":

1. Trends in extent of selected biomes, ecosystems and habitats
2. Trends in abundance and distribution of selected species
3. Change in status of threatened and/or protected species
4. Trends in genetic diversity of domesticated animals, cultivated plants, and fish species of major socio-economic importance
5. Coverage of protected areas

The following have been recommended for medium term implementation:

Group B. Sustainable Use

6. Area of forest, agricultural, fishery and aquaculture ecosystems under sustainable management

Group C. Threats to Biodiversity

7. Nitrogen deposition
8. Numbers and costs of invasive alien species

9. Impact of climate change on biodiversity
Group D. Ecosystem integrity and ecosystem goods and services
10. Marine trophic index
11. Connectivity/Fragmentation of ecosystems
12. Water quality in aquatic ecosystems
Group E. Status of access and benefits sharing
13. Patents
Group F. Status of resource transfers and use
14. Funding to biodiversity
Group G. Public opinion
15. Public awareness and participation

These groups relate to CBD indicator areas, apart from Group G, public opinion, which has been added for consideration in Europe. It has also been suggested that Group E / Number 13 should not be implemented in Europe.

I suggest that indicators proposed under Group A can be implemented rapidly, without recourse to additional research. Some of the other indicators will need further research before implementation.

It must be added that although the proposed set of indicators will provide a major step towards providing information on trends in biodiversity in Europe and will fulfil the major goal of raising political attention, they will not provide a fully comprehensive assessment of the state of biodiversity. More worryingly, they will not provide policy makers and stakeholders with adequate information on the causes of biodiversity loss, nor of the success or otherwise of measures taken to halt biodiversity loss.

But have we sufficient information to establish monitoring programmes that will detect change in the impact of pressures on biodiversity and policy responses to these pressures? I do no think we have. I think much more research is needed on pressures, such as land use change, and responses, such as agri-environmental schemes. This research will be more effective if conducted in an interdisciplinary way, as Rehema White argues, and if linked to networks established to monitor the state of biodiversity (and see below).

Conclusions:

It is of the greatest importance that coordinated monitoring of the state of biodiversity in the European Union starts as soon as possible. At the same time, efforts should be increased to develop better ways of monitoring biodiversity cost-effectively and to quantify both the impacts of the various pressures influencing biodiversity and the measures taken to reduce their impact. Therefore, with regard to research, the following priorities are proposed:

a. The implementation of the proposed state indicators (Group A) requires little or no research. However, researchers should be involved in the coordination efforts (see contribution by David Vackar) being proposed in Europe both to help to access the necessary methodologies and to identify any remaining research needs.

b. Coordination efforts should be expanded to include the medium term implementation of the other indicators listed above – this will require more research but it must be focussed on indicator implementation.

c. At the same time as the proposed state indicators are implemented, a series of intensively monitored sites should be established:

i. To validate the state indicators and monitoring methods used to derive data for these indicators;

ii. To provide a more comprehensive assessment of biodiversity

iii. To understand the relationship between biodiversity, ecosystem function and the services provided by terrestrial and aquatic ecosystems

iv. To quantify the contribution of natural and anthropogenic (including policy influences) on biodiversity

v. To develop improved monitoring and indicators programmes.

Planning a Pan-European monitoring system

Edit Kovacs-Lang, Institute of Ecology and Botany, Hungarian Academy of Sciences, Hungary

I would like to contribute to our efforts in preserving biodiversity in Europe as a member of the Hungarian Bioplatform and as an ecologist who has some experience in biodiversity monitoring on the national level.

Joining Jan Jansen, Jose M. Garcia de Barrio and others I think a reliable, standardized and compatible Pan-European monitoring system should be developed. The opening statements of Allan Watt serve as a very good guideline in thinking of such a system. I think the most critical in developing such a system is the planning phase. Research and all our efforts have to be concentrated therefore on the planning process.

We cannot monitor everything. In a planning process we have to make different selections and decisions about priorities. The first important question is: "What kind of information do we want to get from monitoring?" If we accept the list of CBD COP-7 agreement and the EEA core set of indicators as the desirable main output from the monitoring system, then we have to develop a monitoring system, on the basis of existing experience in Europe, which can fulfil this expectation. From my experience, planning is crucial. We need to clarify what the questions to be answered are, as well as the suitable objects, attributes and methods to get the proper information. This e-mail conference can contribute to this planning process with many useful ideas and experience, but systematic research and practical efforts are needed to unify the concepts and evaluate existing experiences.

RE: Planning a Pan-European monitoring system

Kajetan Perzanowski, Carpathian Wildlife Research Station, Poland

I would like to strongly support the idea of the "standardized and compatible Pan-European monitoring system" being proposed by Edit Kovacs-Lang. Without such an international programme, the comparison of any trends in numbers, biomass, nutrients, productivity etc will be nearly impossible on a European scale. Presently, the common 3-year long scientific programmes do not provide information allowing distinction between annual fluctuations and true long-term tendencies.

Several years ago there was an attempt to transfer the expertise of US Long Term Ecological Research Program to Europe, but due to rather low interest, this initiative never really had a chance to develop. Perhaps now it is a time to retry it?

Structural changes of landscapes

Klaus Henle , UFZ Leipzig-Halle, Germany

SUMMARY: Structural changes of landscapes are a pervasive corollary of global change. I argue that we need research focusing on the development of indictors of species and ecosystems sensitivity to structural changes and monitoring systems for structural changes of landscapes. These need to be combined with indicators for structural landscape effects of policies and policy instruments that contribute to safeguarding large unfragmented and undisturbed habitats while providing for the livelihood of the regional population.

Structural changes of landscapes are one of the most pervasive corollaries of global change with profound effects on biodiversity on all levels. While we have made considerable progress in analysing and understanding the effects of landscape change, especially fragmentation, on species survival, progress on managing processes that lead to structural changes of landscapes and to mediate their effects on biodiversity have been slow.
Several main research deficiencies exist:

Although several hypotheses have been made about indicators of the sensitivity of different species and habitats to structural changes, few of them have been tested rigorously. To develop and test such indicators, we need to compare species and habitat sensitivity and their biological characteristics across different landscapes. We need to combine such approaches with research that combines dynamic landscape models with models of population viability.

We have insufficient understanding of the drivers of structural changes of landscapes and we need easy to monitor indicators that quantify those features of structural landscape changes that are of particular relevance for the conservation of biodiversity. For example, we have only rudimentary understanding of how the various policies influence biodiversity through their short- and long-term effects on structural changes in biodiversity (from the local to the regional, national, European, and global level).

So far, research on the effects of landscape structure on biodiversity was undertaken with only very rudimentary integration of those societal aspects that are decisive for the maintenance or loss of large unfragmented and undisturbed habitats. Thus, this research has seen only limited success in halting the decline of habitat loss and fragmentation. Therefore, we need to integrate research on the effects of structural landscape changes with the development of policy instruments that contribute to safeguarding large unfragmented and undisturbed habitats while providing for the livelihood of the regional population. For example, most countries have systems for allocating state financial resources for acknowledging services to society of particular cities and/or regions. However, considerable scope for improving such systems still exists for a better accounting of the contributions of those regions that contribute to the conservation of landscapes with low fragmentation and disturbance levels.

RE: Structural changes of landscapes

Rainer Muessner, Centre for Marine and Environmental Research (CIMAR), Porto, Portugal

Klaus Henle raised in his contribution the very important point of indicators for structural changes in landscapes and furthermore the research need to combine these knowledge with policies and policy instruments, that can be seen as main drivers for these structural changes. He mentioned the poor progress so far to manage these processes and to mitigate their effects on biodiversity and I fully support his opinion.

While in the recent years several scientific and policy initiatives on indicators for structural changes have been developed (and there is a clear point in enhancing these systems further and test its applicability) the situation to detect, quantify and evaluate functional changes is even worse.

If we look at overviews on landscape indicators (OECD 2000, Wascher 2002) we see that there is a clear imbalance between structural indicators and functional indicators. For example most large scale indicator systems are based on indicators of landscape structure, because these are easier to categorize and to detect (GIS, statistics), but it is much more difficult (methodological) to develop indicators for landscape functions and processes. Very often the landscape structures are still persistent, but the underlying functions and processes are already inactivated or irrelevant. While from the policy side the "multifunctionaltity of cultural landscapes" is always emphasised (OECD 2001,Potter 2002), the scientific answer how to detect, measure and evaluate these functions (i.e. aesthetic, recreational, economic and ecological) properly is still missing.

Therefore I like to endorse the research deficiencies listed by Klaus to structural and functional changes of landscapes.

RE: Structural changes of landscapes

Kevin Parris, OECD, Montreal, Canada

Further to the point raised by Rainer Muessner, re landscapes, OECD has also recently published the book: Agricultural Impacts on Landscapes: Developing Indicators for Policy Analysis (Oslo, Norway, October, 2002). Norwegian Institute of Land Inventory (NIJOS) and OECD joint publication, July, 2003

In addition, a further book, mentioned by me in an earlier message, covered: Agriculture and Biodiversity: Developing Indicators for Policy Analysis (Zurich, Switzerland, November, 2001). OECD publication June, 2003. These books are freely available at the OECD website at: http://www.oecd.org/agr/env/indicators.htm

Before considering new frameworks and proposed indicators to analyse and measure changes in landscapes and biodiversity, it might be useful for colleagues to consult the Summary recommendations of these two reports which involved many experts from most EU countries.

Research priorities inspired by the Birds Directive

Ian Burfield, BirdLife Europe, The Netherlands

SUMMARY: In preparation for a meeting of the ORNIS Scientific Working Group on research needs for the Birds Directive in January 2004, the following research priorities were identified by BirdLife International during a consultation exercise within the European Partnership.

1. Sustainable long-term monitoring: Many contributors have already highlighted the critical importance of long-term monitoring schemes and the need for them to be sustained by modest financial support. In many cases, NGOs play a vital role in both running these schemes and in training and maintaining the large army of volunteers who actually collect the field data. However, as 'monitoring' has traditionally been divorced from 'research', many such schemes receive little or no Government support and face uncertain financial futures. Now that Governments are finally realising the value and cost-effectiveness of such schemes, they should acknowledge that long-term monitoring is just as important as cutting-edge research, and thus be prepared to commit the very modest sums required to support it. They should also consider that one of the best ways to improve public awareness of - and participation in - stopping biodiversity decline is to encourage people to get involved in volunteer schemes. Integrated Population Monitoring Schemes should also be encouraged, combining and promoting the results of detailed scientific studies with data from e.g. bird ringing, hunting bags and citizen science.

2. Baselines, targets and network coherence: While it is inarguable that many species are currently at levels way below their natural carrying capacities, we have little idea what their actual current carrying capacities are. Research could help by mobilising and synthesising the large amounts of existing historical data, and then using modelling approaches to calculate meaningful baselines and set realistic targets, based on different scenarios. Without such targets, it is often difficult for politicians or the public to attach much meaning to the data provided by monitoring schemes. The progressive shift in Natura 2000 objectives - from establishing the network to maintaining it - means we need research on how to set the right targets - at species population level, site level and network level. Scientific rationales on how to set targets and assess the coherence of protected area networks remain thin.

3. Predictive modelling and climate change: Much more emphasis on this is required, as – together with indicators – this is the basis on which decision makers act. The high political profile of climate change is due partly to researchers being able to producing predictive models of various plausible scenarios. That we cannot yet match this is one of the reasons that the biodiversity crisis has fallen off the political agenda. To rectify this, we need many more systematically-recorded data, collected synchronously using standardised methods, to provide the raw material for testing and verifying models. For instance, using data from the EBCC Atlas, Rhys Green and Brian Huntley have modelled the recent geographical distribution of European breeding birds in terms of just three bio-climate variables. They have used this model to map the 'envelope' in which the climate is likely to be suitable for each species in the late 21st century, under the most plausible climate change scenario. An atlas containing the results will be published in 2005, providing a means for assessing the implications of climate change for Natura 2000 - e.g. how can we accommodate the predicted species redistributions in the existing network?

4.Gap analysis and prioritisation: Considerable detailed autecological research has been carried out on the requirements of many European species, especially on popular and well-studied groups like birds. However, the results are often unpublished, languish in obscure journals, have not been translated, or are otherwise difficult to access. It is essential that this existing science is inventoried, reviewed and presented in a non-technical and

accessible way. We need mechanisms to promote effective information exchange and technology transfer between researchers in different countries, e.g. user-driven databases of publications on the ecology, declines and recoveries of particular species or communities. As well as helping to prevent wastage in terms of repetition, this would also help to focus new research projects on really policy-relevant issues. The RSPB has just employed someone to do precisely this job for farmland birds, but there remain many gaps to be filled.

5. Habitat management for biodiversity: Over the past decade or so, detailed investigations into farmland bird declines have successfully pinpointed the needs of species, the causes of their declines, and how to reverse these with practical measures and changes in policy, i.e. agri-environment schemes. This approach should now be extended to other habitat types and ecosystems, both terrestrial and aquatic. Such research should aim to develop an evidence-based approach to biodiversity management, following similar developments in the medical world.

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