Biotic Resources in a Changing World:

# *Science for Better Governance*

Report of an Electronic Conference, April 2003

BIOplatform

**EPBRS** EUROPEAN PLATFORM FOR BIODIVERSITY RESEARCH STRATEGY

Greek Biodiversity Platform

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# Preface

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 'Biotic Resources in a changing World: Science for Better Governance'. The report also contains contributions to the joint e-conference organised with Marbena, focussing on the marine aspects of the issue. The results of the Electronic Conference will be presented at the EPBRS delegates meeting in Molyvos (also known as Mythimna) on Lesvos, Greece, from 23rd to 26th May 2003.

This report contains a preface and introduction to the e-conference, a summary of the contributions followed by the contributions themselves, references and contributors' contact details.

# Introduction

Biodiversity provides a huge variety of goods and services, from food and water to chemicals and tourist attractions. Human society wholly depends on these biological resources that are threatened by anthropogenic pressures. The interrelationship between biodiversity and natural resources, in the broad sense, acquires a broader interest in the perspective of global change dynamics, both at the physical and biospheric domain and the socio-economic domain. For example, climate change is expected to cause negative impacts upon fisheries, a major biotic resource. Or, the use and trade of species or genes in a global economy generates important questions and conflicts over Intellectual Property Rights, a major issue of international politics.

Within the framework of EU policies, the utilitarian vision of biodiversity has not yet been examined as to its importance regarding the implementation of major environmental and economic policies such as the agro-environmental policy, the reform of CAP, or the Habitat Directive. During the last years, the EU appears to push forward towards the perception of biodiversity as 'resource' closely related to goods, services, risks and policies.

In that perspective, the meeting on "Biotic resources in a changing world" focuses on the following key-points:

- Global change drivers and production sectors (e.g. fisheries, agriculture, preservation of nature quality)
- Biotic resources and the rise of IPR conflicts and economic opportunities
- Biotic resources as a means for innovation and alternative economic scenarios for local development, especially within protected areas
- International conflicts around scarce biotic and natural resources.

The questions that we hope to consider in this electronic conference are:

1. What main biotic resources do we need to consider, and how do we synthesize our knowledge to better understand the risks associated with our dependency on biodiversity?
2. How can science benefit from or contribute to local knowledge, ethnobiology and local culture, and how can biodiversity science contribute to technological approaches, Intellectual Property Rights (IPR), fair and equitable access and benefit sharing?
3. How can we integrate our knowledge into new technologies, innovative plans for local development and biodiversity conservation?

## Summary of contributions

**Session 1:** *What main biological resources do we need to consider, and how do we synthesize our knowledge to better understand the risks associated with our dependency on biodiversity?*

Semantics were very much the focus of a strain of contributions, with the ever-present discussion of meaning of biodiversity. Lorenzo Ceccolini and Jari Niemela both defined biodiversity as "all living organisms", and emphasized the need to consider biodiversity as a whole biotic system, with different organisational elements, and where even the smallest detail had to be taken into account in order to avoid a cascade of extinctions. Lorenzo Ceccolini, Jari Niemela, Martin Sharman and Alan Feest all pointed out that biodiversity was not simply a list of species, but a combination of functional and compositional aspects. There was a definite emphasis on the fact that biodiversity was a highly complex trophic web, for which we still had very little knowledge of the effects on biodiversity of human activities, the effect of extinctions in natural systems (see Michel Loreau's contribution for example), or the true value of biodiversity to humans (Allan Watt, Caspian Richards, Martin Sharman, Rainer Muessner).

Lorenzo Ceccolini's anecdote about cheese led Tor-Bjorn Larsson to raise some questions regarding the market value of local products, different types of biodiversity involved in local areas, and the impact of traditional knowledge in biodiversity. This then led to semantics over the "local" concept in a second Ceccolini contribution and a contribution by Barbara Tomassini. Lorenzo Ceccolini argued that a local product sold in a supermarket in another area could no longer be considered as local, as it would then loose the strong link with local cultural aspects. Both Barbara Tomassini and Caspian Richards agreed on the fact that "local" products were appealing to consumers for a number of reasons, and Caspian Richards went on to link this issue towards biodiversity conservation. He discussed the fact that biodiversity conservation could be focussed in two ways: by promoting the conservation of "local" biodiversity and by promoting the intrinsic value of biodiversity.

With the example of the "Integrated Management of European Wetlands" project, Sandra Bell highlighted the fact that although local people were often quite willing to help in conserving local wildlife, confusing legislation and the perception that their local ecological knowledge and culture were not being respected could prevent local people from actively participating in biodiversity conservation. Rainer Muessner added a word of caution by saying that although local knowledge, participation and integrated decision making were important in local biodiversity conservation, some aspects could not be negotiable under national/international laws.

The second question of the e-conference, i.e. why biodiversity should be conserved, was dealt with by a number of contributions. Jari Niemela highlighted the fact that biodiversity resources and ecosystems goods had to be maintained in order to benefit from the vital services that biodiversity offered. Martin Sharman however argued that because we did not know the ecological value of biodiversity, protecting biodiversity for the goods and services it produces for humans could lead to a philosophy of conserving certain aspects of biodiversity we value (in economic, aesthetical or cultural terms) and discarding others which we perceive have no value for us. John Hutcheson disagreed with the concept that ecological value or quality of biodiversity was not scientifically measurable, and argued that conservation could only be achieved through a change in the perception of humans towards biodiversity. Although there is no doubt that humans depend on tangible resources such as food, water and air for survival, Allan Watt concentrated on the less tangible, but perhaps just as or even more essential resources biodiversity provides us by discussing biophilia. He argued that more practical research was needed to better understand our bond with biodiversity, and supported the view that we should conserve all biodiversity. Rainer Muessner added that to promote

biophilia, the improvement of environmental education methodology and effectiveness was needed. Although this may all be ethical commendable, Tor-Bjorn Larsson argued that certain priorities had to be set in biodiversity exploitation and resource allocations, which would be best achieved by providing politicians and policy-makers with the relevant information. In view of this, Kajetan Perzanowski suggested eco-regions encompassing all levels of organisation, as basic conservation units- the question remains how to identify these eco-regions and how to secure them as conservation areas. Christian Kleps elaborated on this theme and suggested that existing environmental agreements between countries should be considered when establishing eco-regions.

In order to understand our dependence on biodiversity better and the impacts of biodiversity changes on the functioning of ecosystems, Michel Loreau, Jari Niemela Klaus Henle and Martin Sharman suggested a synthesis of both scientific knowledge (on ecological changes and extinction processes) and societal applications of that knowledge. In order to reach an estimation of biodiversity quality, Alan Feest suggested measuring the biodiversity qualities of as many taxonomic groups as possible and compare these between areas. This could be achieved through global networks of research groups according to Klaus Henle. Michel Loreau summed up the question by adding that although scientific knowledge could help in determining why and what biodiversity to conserve, ultimately, biodiversity conservation was a societal choice.

Jurgen Tack closed the discussion by suggesting that instead of trying to determine the risks associated with our dependency on biodiversity, we should consider how to synthesise our knowledge to understand the benefits associated with our dependency on biodiversity. In both cases, the first step it to understand ourselves. Erling Berge and Kajetan Perzanowski agreed that the concept of humans as an integral part of biodiversity had to be considered in biodiversity conservation and together with Caspian Richards, Jurgen Tack and John Hutcheson he emphasised the importance of changing humans' attitudes towards biodiversity and conservation but added that education was insufficient and that understanding the complex human structures and dynamics had to be considered together with biodiversity dynamics.

**Session 2:** *How can science benefit from or contribute to local knowledge, ethnobiology and local culture, and how can biodiversity science contribute to technological approaches, Intellectual Property Rights (IPR), fair and equitable access and benefit sharing?*

Improved communication between the different stakeholders involved in biodiversity conservation (not only the local or indigenous communities, as pointed out by Heidi Wittmer) was a main theme of this last session. According to Caspian Richards, scientists have an important role in communicating the intrinsic value of biodiversity to people, and could benefit from and contribute to other people's knowledge in this way. Michalis Skourtos, however, argued that science and local knowledge could only benefit from one another once the values argument was abandoned and communication was improved. In his contribution, Martin Sharman pointed out that a difficulty in benefiting from local knowledge was the importance of cultural perspective (if humans are part of, or outside, nature). However, indigenous knowledge should be regarded as intellectual property, and any research, including the identification of local knowledge in Europe and the attitudes towards indigenous or local knowledge, should involve the local community and help perpetuate that knowledge. Heidi Wittmer added that research should also focus on understanding how property rights were being assigned and negotiated within the CBD framework. Sandra Bell agreed that the acknowledgement of indigenous knowledge was essential in conservation initiatives. And, even though the nature of indigenous knowledge involved long-term and costly studies, indigenous knowledge should be integrated in an inter-disciplinary network involving social and natural scientists.

The second main focus of discussion revolved again on the values attributed to biodiversity. Felix Rauschmayer took the debate on biodiversity values to more practical grounds by arguing that it was important to look at both intrinsic and instrumental values at the local level, with local communities actively involved in conservation. The role of scientists here, according to Felix Rauschmayer, is to combine local knowledge and values with scientific knowledge, develop decision-making structures and implement them at the local level. Gina Green described such an approach in the tropics, the Equator Initiative, promoting community-based activities that integrate biodiversity conservation with sustainability. Gina Green added that a major priority was to understand the links between policy and local action through an integrated framework reporting to civil society the benefits or costs of such projects. Still on the notion of biodiversity values, Timothy Swanson and colleagues identified a number of approaches designed to value biodiversity, including non-anthropocentric and non-market values. Felix Rauschmayer added that one had to identify the whole range of values associated with biodiversity, capture and aggregate them as a multi-criteria decision aid.

**Session 3:** *How can we integrate our knowledge into new technologies, innovative plans for local development and biodiversity conservation?*

Martin Sharman discussed biodiversity loss as a measure of sustainability concluding that the only way to halt that loss would be to change humans' attitudes from growth to sustainability. Allan Watt suggested that a way to monitor that biodiversity loss was to improve our knowledge about human attitudes and the drivers of biodiversity loss. In order to achieve this, collaboration and more importantly integration is needed between researchers working on the biological and socio-economic drivers of biodiversity loss to reach an integrated framework. A method to achieve better multidisciplinary integration could be the workshops suggested by Sandra Bell. She describes a pilot project where both types of scientists get together and carry out a project with the goal of achieving interdisciplinary understanding. However, Caspian Richards emphasized the need for a wider scope than simply the academic community for people to recognise for themselves the intrinsic value of biodiversity. Only by working with natural and social scientists as well as people outside the research community, can we have a better understanding of attitudes towards nature. With reference to marine ecosystems, Christos Arvanitidis and Anastasios Eleftheriou added that knowledge alone might not be enough and that policy changes regarding energy production and sustainable economy might be more powerful at the EU level.

On the issue of how science can contribute to governance, Martin Sharman emphasised the difficulties linked to differences between policy makers, who need quick, if incomplete information, and scientists, who work to reduce ambiguity as much as possible using long-term research. Josef Settele suggested that in order to give more than an educated guess when advising on policy, and to be less biased, a "best practice manual" could be to ask scientists working in a related field to submit joint statements to policy makers. Rainer Muessner agreed with the fact that scientists should give policy makers a quick answer (if a little shaky) rather than no answer at all in order to stay "in the game". However, he was more reserved about the idea of a "best practice manual" and argued that this manual might be overshooting the mark when advising on policy. Katalin Torok added that non-policy relevant research should also be carried out, and that the solution was to improve communication and understanding between policy makers and scientists by involving young experts more. Marina Michaelidou agreed with this statement by adding that both cultural and biological aspects had to be considered when trying to implement sustainable approaches.

A few practical ways of promoting sustainability included the description of: distributed economies by Allan Johansson, sustainable reserves by Alpina Begossi and population models and Ecological Risk Assessments by Yiannis Matsinos. Alan Feest also mentioned the

possibility of considering risk analysis and hierarchies of probability, but concentrated more on the idea of encouraging scientists to conduct their research in view of decision-making.

Finally, Konstantinos Hatzidakis discussed the move towards the promotion of environmental protection for increased development and illustrated this point by looking at local development, eco-tourism, the Structural Funds programmes and Cohesion Fund projects. He also emphasizes the need for a radical change in mentality regarding the real value of natural resources conservation, especially in Southern European states.

**Summary of the joint BioPlatform-Marbena session:**

Anastasios Eleftheriou highlighted two main aspects of marine biodiversity in this first contribution. The first aspect is that marine biodiversity in the Mediterranean is changing due to factors such as invasive species, habitat loss and a host of anthropogenic pressures. However, a second aspect of Mediterranean biodiversity is that, while it is one of the best studied in the world, major gaps in knowledge still exist. He called on contributors for this session to concentrate on ways to value change in marine biodiversity and ways to improve our knowledge of still unknown marine biodiversity, as well as the cost associated with not knowing.

On the issue of valuation of change in marine biodiversity, Roberto Danovaro could identify two approaches. The first would be to know how much profit we could gain from a species or habitat and the second would be to ask people how much they would be ready to pay for the possibility of preserving biodiversity through a classical market investigation. The advantages of such an approach would include the better understanding of public perceptions, a guide for politicians as to the value of biodiversity and give scientists a feel for how they need to educate people about biodiversity conservation.

Ferdinando Boero asked whether the value of biodiversity was value for humans, i.e. what humans gained from biodiversity. As for the cost of not knowing, he argued that in both managerial and cultural sense we could not afford ignorance. However, he later added that an alarmist view on species loss could only lead to the scepticism of politicians and the general public towards science. William Silvert replied in defence of ignorance, by arguing that we did not need to have a catalogue of species in order to make sound recommendations regarding biodiversity conservation. He also highlighted the fact that scientists could not afford to know everything there was to know about ecosystems or species if they were to be more effective as regards to politicians and managers. Lydia Ignatiades stressed that our greatest unknown was the impact of human activities on biodiversity, and that the consequences of this impact could have dramatic effects on human well-being.

Jakov Duleiae, Lovrenc Lipej and Irina Kulakova described the Adriatic ichtyofauna and Nematode Faunal investigations in their contributions. Yuvenaly Zaitsev agreed with Anastasios Eleftheriou that the Mediterranean Sea should be one of the best studied in the world, and added that the same should be true of the Black Sea.

As for research priorities in the Mediterranean, Samir Grimes identified the following: species inventory, species protection criteria (in order not only to protect “star” species), threats on biodiversity and the role of species in sustainable development and local population stabilisation when dealing with important economic species.

The second issue dealt with during this session was the role of science in governance. Martin Sharman emphasised the difficulties linked to differences between policy makers, who need quick, if incomplete information, and scientists, who work to reduce ambiguity as much as possible using long-term research. Ferdinando Boero acknowledged the fact that scientists tend to come up with multiple problems and solutions attached to a simple problem, but

warned against scientists who give quick answers to policy-makers simply to get funding. As well as differences in time scales between policy-makers and scientists, Ian Davies also identified differences in terms of opportunities, risks, utilities and priorities. Together with Lydia Ignatiades, he thought the best policy was to be honest, giving an unbiased answer, highlighting possible areas of doubt and not simply giving the answer that the policy maker wants to hear.

## Annex I - List of contributions

| Session and Title of Contribution | Contributors |
|---|---|
| **Session 1 Biotic resources: potential and risks** | |
| Potential and risks: Introduction to session 1 | Andreas Troumbis (Chair) |
| Cheese and Biodiversity Conservation | Lorenzo Ceccolini |
| RE: Cheese and Biodiversity Conservation | Tor-Bjorn Larsson |
| Local and global: an important issue in agricultural biodiversity | Lorenzo Ceccolini |
| RE: Local and Global | Barbara Tomassini |
| Local produce and biodiversity conservation | Caspian Richards |
| Local biodiversity and conservation conflicts | Sandra Bell |
| RE: Local biodiversity and conservation conflicts | Rainer Muessner |
| Biodiversity conservation and knowledge synthesis | Jari Niemela |
| RE: Biodiversity conservation and knowledge synthesis | Alan Feest |
| RE: Biodiversity conservation and knowledge synthesis | Phil Lambdon |
| RE: Biodiversity conservation and knowledge synthesis | Martin Sharman |
| Biodiversity conservation: Choice or chance? | Tor-Bjorn Larsson |
| Ecological values and biodiversity conservation | John Hutcheson |
| Ecological value of biodiversity | Martin Sharman |
| RE: Ecological value of biodiversity | John Hutcheson |
| Biodiversity and biophilia | Allan Watt |
| RE: Biodiversity and Biophilia | Rainer Muessner |
| Conserving biodiversity with, or from, humans? | Erling Berge |
| RE: Conserving biodiversity with or from humans | Kajetan Perzanowski |

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| Consequences of biodiversity loss for ecosystem processes and services | Michel Loreau |
| Eco-regions for biodiversity conservation | Kajetan Perzanowski |
| RE: Eco-regions for biodiversity conservation | Christian Kleps |
| RE: Eco-regions for biodiversity conservation | Kajetan Perzanowski |
| The need for a synthesis of ecological knowledge and global research networks | Klaus Henle |
| Wrong question | Jurgen Tack |
| **Session 2 A new generation of rights and opportunities for human communities** | |
| Introduction to session 2 | Andreas Troumbis |
| Discussing biodiversity in public | Caspian Richards |
| RE: Discussing biodiversity in public | Felix Rauschmayer |
| Local knowledge- a clash of cultures? | Martin Sharman |
| Local public values of biodiversity | Felix Rauschmayer |
| The role of indigenous knowledge in biodiversity conservation | Sandra Bell |
| Biodiversity conservation through improved communication and benefit-sharing schemes | Michalis Skourtos |
| Biodiversity values and uses | Gina Green |
| Biodiversity assessment and human adaptation to environmental changes | Anne Larigauderie |
| Approaches to the Estimation of the Values of Biodiversity: Non-market and Market Approaches | Tim Swanson et al. |
| RE: Approaches to the Estimation of the Values of Biodiversity | Felix Rauschmayer |
| **Session 3 Biotic resources: From exploitation to innovation and local development** | |
| Comments on session 2 and introduction to session 3 | |
| Repent! The end is nigh! | Martin Sharman |
| How will we know when the end is nigh? | Allan Watt |
| RE: How will we know when the end is nigh? | Sandra Bell |
| RE: How will we know when the end is nigh? | Christos Arvanitidis and Anastasios |

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|---|---|
| Aggregation in marine ecosystems | William Silvert |
| Fuzzy management | William Silvert |
| Assumptions | Ferdinando Boero |
| Marine biodiversity and EU policies | Lydia Igniatiades |

**Session 1**- What main biotic resources do we need to consider, and how do we synthesize our knowledge to better understand the risks associated with our dependency on biodiversity?

**Introduction to session 1: Potential and risks associated with biotic resources**- Andreas Troumbis (E-Conference chairperson), University of the Aegean.
KEYWORDS: biotic resources, utility, economic value, biodiversity loss.
SUMMARY: Progress in biodiversity and global change science in the last decade has offered significant conceptual evolution in our understanding of major biospheric processes, their dependency and influence upon the various components of the living world and their importance for the welfare and security of human populations.

Species and their physiological processes, e.g. biomass production or biochemical processes, have always been considered as a material basis and a renewable capital for the primary production sector (e.g. agriculture, forestry or fisheries). To some extent this was also the case for genes, nature or 'environment' *sensu lato*, that were also perceived as capital for a variety of production sectors such as pharmaceuticals and tourism. In the 1990s, the tremendous 'mutations' in ecological theory with the emergence of the biodiversity concept, in bio-technological capabilities and in the perceptions and choices of consumers becoming progressively more environmentally aware and friendly, have led to a recognition of biodiversity components as usable entities from a utilitarian point of view, i.e. as resources.

Thus, biotic resources acquire a clearly distinct identity from natural resources (e.g. water or fiber) perceived as abiotic, for two main reasons:
- The functional role of biodiversity, that is the way ecosystem-level functions and processes are mediated by interacting organisms, i.e. genotypes sequentially organised into diverse ecological entities, has been directly associated to goods and services for humans. For example, trees are not only constituents of a forest committed to industrial use, but also mediators of C fixation and sequestration, refuges for wildlife and components of landscapes.
- Biodiversity has a built-in genetic capital, resulting from an irreplaceable evolutionary history, of biological solutions to the problems set by environmental pressures upon organisms.

If biodiversity components are identified as resources, then there is an obvious scientific need to develop methods:
- To identify their utility for various uses; utility screening protocols based on traditional local knowledge and modern techniques per production sector should be developed to catalog potential uses.
- To value them both in terms of direct economic value as food, source of medical substances and pharmaceuticals, potential agents for crop improvement or biological control, and of indirect and dynamic mediators of ecosystem services, such as primary and secondary production, regulation of climate, maintenance of atmosphere quality, regulation of hydrological cycle, maintenance of water quality, maintenance of soil fertility, etc.

Although remarkable inputs are recorded in the above mentioned scientific fields, i.e. there is a flourishing literature in ethnobiology or ethnopharmacology and environmental or ecological economics, this conceptual evolution does not yet significantly influence large-scale production practices. In agriculture, for instance, mass food production is based upon roughly one hundred species, less than a tenth of which cover over 80% of the global nutritional needs. Furthermore, local natural varieties or races of agricultural species, well adapted to local environmental conditions, are continuously abandoned in favor of more productive selected 'hybrids', the biophysical limits of which are pushed over *via* high-input agronomic practices.

Since biodiversity is eroded with an alarming pace globally, we are not only losing species, but also the known and unknown resources associated with them. Therefore, besides the well-known arguments for biodiversity conservation within a global change discourse,

additional arguments emerge from the loss of biotic resources and their secondary effects for the human communities:
- Opportunities lost for local development, based on the 'exploitation' of these resources that are better adapted to local conditions and/or carry the benefit of local identity for products or services.
- Narrowing the domain of application of ecological engineering solutions for environmental problems, that constitutes low-cost alternatives to large technological substitution of natural ecosystem processes.
- Increase of risks associated with the fragility of production systems based on less bio-diverse resource basis.

The questions that we hope to consider in this electronic conference are:
1. What main biotic resources do we need to consider, and how do we synthesize our knowledge to better understand the risks associated with our dependency on biodiversity?
2. How can science benefit from or contribute to local knowledge, ethnobiology and local culture, and how can biodiversity science contribute to technological approaches, Intellectual Property Rights (IPR), fair and equitable access and benefit sharing?
3. How can we integrate our knowledge into new technologies, innovative plans for local development and biodiversity conservation?

In this first session of the e-conference, we encourage you to send contributions addressing what main biotic resources we need to consider, and how best to synthesize our knowledge to understand the risks associated with our dependency on biodiversity.

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**Cheese and biodiversity conservation**- Lorenzo Ceccolini.
KEYWORDS: Natural selection, sustainability, vital energy.
SUMMARY: Uniqueness of all biological resources and relevance of details as pillars in risk understanding of our dependency on biodiversity.

Recently I had the will to learn how to make cheese. After a few investigations, I was directed to a Sardinian man who makes traditional goat's cheese every morning. It was an exhaustive lesson. A few days later I had the opportunity to take part in another cheese lesson held by a Sardinian woman. Recently I had yet another chance to visit a cheese maker in central Italy, from whom I collected additional information about the cheese making process. I got three recipes, each one slightly different from the others. Do I have to reject two of them, keeping only the easiest to make, or cheapest to do, or the most productive one? No, I will keep all three recipes as important records of cheese knowledge. May we use this anecdote speaking in terms of need of consideration of biological resources? Yes, with a bit of fantasy.

But what we mean by biological resources? Biological resources are all living organisms. In a more complete term we may view them as a form of energy: vital energy. All organisms are important as unique pieces of the global life puzzle. There are many examples that demonstrate how important biological resources are for the whole biotic system (i.e. organisms help organisms). An interesting study is going on in the Amazonian region: many different size plots of virgin tropical forest (or 'islands') are preserved, surrounded by a depleted area, used as pasture for cattle. The main task of the project is to find a correlation between the size of the plots and theirs biodiversity, in time. After years of measurements, analysis and calculations, the first results are clear. The smaller the size of the plot, the more rapid the erosion of biological variety inside them will be. Our world is becoming more and more similar to a small plot, surrounded by oceans of desert region. As the resources (in terms of food) are becoming fewer, animals and plants that need food to maintain their vital energy are disappearing, causing a dramatic cascade effect. All biological resources have to be taken into account. If maize has to be considered as a crucial resource due to its extensive use in human food consumption, teosinte, as natural ancestor of maize, deserves equal attention, as a formidable resource for the future of the corn belts of the world. The main hints for our understanding about biodiversity are coming from details present in the natural system. Many principal rules of the natural world are found in the smallest details. The study carried out in the Galapagos, is one such case in which the study of a detail such as the length of the beak of

the finches, brought a whole new knowledge about diversity in living organisms. The finches are astonishingly fast in adapting themselves to stress situation through natural selection. As human beings, compelled to a much slower adaptation process, we should be aware of the risks in diminishing our plot size world.

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**RE: Cheese and biodiversity**- Tor-Bjorn Larsson, European Environment Agency.

The nice example of Italian goat cheese presented by Lorenzo Ceccolini raises several general issues related to agriculture and biodiversity:
- Market value of local products: Is there already today a national market for these three types of goat cheese, i.e. are these products sold more widely, stating their origin? Are the different types of cheese distinctive or would (today's or future) market value mainly build upon the attraction of a local origin?
- Biodiversity: Are there any genetic differences between the goat breeds of the three areas (reflected in the cheese)? Or in the grazing areas (but perhaps phenotypic differences are not part of the biodiversity concept?).
- Traditional knowledge: Does the differences in production methods reflect long-time adaptations to the specific conditions of the areas?

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**Local and global: an important issue in agricultural biodiversity**- Lorenzo Ceccolini.

Let me consider the issue. Although one of the three cheeses was sold in an informal way, it is common to see a local product sold in every part of the nation, through the modern commercial network.

But another question is then raised: When I buy a local product of the south, sold in the north, is the adjective "local" still applicable? Massimo Angelini, an expert in biodiversity research in agriculture, taught me that this is not a local product anymore. Indeed a local product has a strong link with the place of production, has a deep intimacy with the local people who have produced it for a long time, and traditions that lie behind this product reflect the circumscribed living customs. A promising mirage for a future valuable maintenance of diversity in products and knowledge would be that every region has its own local product, and not that every local product could be found in every supermarket of the nation.

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**RE: Local and global**- Barbara Tomassini

In my understanding the 'local' character of a product is not diminished by the fact that it can be found in other parts of a country. Indeed, I think that this helps to make consumers aware that the specific product, for some reasons, can only be produced in a particular part of the territory or country and that, in this sense, is a unique local production of that area.

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**Local produce and biodiversity conservation**- Caspian Richards, Macaulay Institute.
KEYWORDS: Decentralised production, intrinsic value, local biodiversity, biodiversity conservation.
SUMMARY: The author discusses the appeal of decentralised forms of production to consumers and makes a parallel with the possible effects of such approaches to views regarding biodiversity conservation.

The issue of whether products are 'local' or not, and what difference this makes to their desirability to consumers, is an interesting one. There is obviously a significant difference between a food production system based on selling all produce at or close to the place of production, and one based also on decentralised production but where products are widely circulated between regions. Both are in some respects in opposition to the kind of centralised food production system with national distribution that has come to dominate in the UK. My impression is that both decentralised forms of production appeal to at least a certain kind of

consumer, the first because 'local' products are more attractive (due to a kind of brand loyalty, desire to support the local economy, the belief that 'food miles' should be minimised, etc.), the second because people like to know that the product was local to somewhere (I suspect because the precise place of origin of much of the produce sold in our supermarkets cannot be given, since it is just drawn from the centralised vat), even if not their own locality. People may also like to buy produce from places they are familiar with or have a positive impression of, as well as of course from places famous for particular products (Parma ham etc.), whose trademarks the EC has been keen to protect. As Barbara says, the fact that for some reason (production conditions, trademarks...) a particular product can only be produced in a specific region is no doubt an important part of its appeal.

To relate this back to biodiversity, this may help to think about what people might value in the diversity of life-forms (presumably the reason why cheeses were mentioned in the first place...), but also to distinguish some differences between the two cases. Martin argues that there are dangers in arguing for biodiversity conservation on the grounds of the value of biodiversity to humans, and I think this is right; but at the same time, when trying to persuade people to buy into the vision it is inevitable that this strategy will be called upon at times. A crucial difference between, say, wild birds and cheeses is that wild birds cannot be distributed according to consumer demand. I also doubt that most of us associate anything more than a handful of species with well-defined places (as opposed to regions or habitat types), perhaps partly because of the failure of ecological processes to respect administrative boundaries or trademarks. When arguing that biodiversity has to be preserved, one may therefore find oneself required to focus on the one hand on persuading people to look after their 'local' habitats, and on the other hand on promoting the intrinsic value of diversity - this general case would have to be presented on intrinsic grounds, as experience of non-local species is limited to travel (and individuals cannot travel everywhere) and to the circulation of images rather than the real thing - although admittedly images may still help the cause, but more for particular photogenic species rather than for diversity per se. Persuading people of the intrinsic value of biodiversity is quite a challenge, especially given that there is no real consensus on what it is, but hopefully later sessions will deal with what intersection might exist (or be established) between ecologists' and other people's perceptions of the matter.

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**Local biodiversity and conservation conflicts**- Sandra Bell, University of Durham
KEYWORDS: Fishing, local knowledge, cultural and societal issues, conservation conflict.
SUMMARY: The author argues the fact that the reluctance of local people to conserve biodiversity in wetland areas may be due to confusion caused by legislation and legislation implementation and the feeling that their knowledge, as well as cultural and societal traditions are not being taken into consideration in the biodiversity conservation decision-making process.

To move from cheese to fish, one of the factors that is emerging from our research on the 5th Framework Project "Integrated Management of European Wetlands" is not so much the reluctance of local people to make efforts towards conservation of biodiversity as the confusing raft of legislation and the many bodies that are supposed to oversee and implement that legislation.

Local people also feel that they have not been consulted about the formulation of the rules that they are supposed to abide by and their own environmental knowledge is overlooked.

As far as fishing is concerned some people have a deep and personally felt relationship with the waters that they fish and the species that they capture. There are often social and cultural meanings attached to fishing which make it a focus of local identity. In these circumstances, many local people feel that they should be treated differently to "outsiders". They also often feel that regulations created by people they perceive as distant bureaucrats, be they at national or EU level, have no real meaning for them. Sometimes they break the rules in order to flout what they see as interference.

We find that although people express concern for the state of the fish stocks they also feel that they have a right to exploit the products of their own waters. Regulation of commercial fishers is more acceptable, but when local people want to take fish for their own consumption they feel it is their right to do so even at times of the year when fishing in banned. This is just as true in places where people can afford to buy non-local fish as in places where the fresh water fishery is a vital source of household subsistence.

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**RE: Local biodiversity and conservation conflicts**- Rainer Muessner, CIMAR.
KEYWORDS: Local knowledge, conservation, legislation.
SUMMARY: The author acknowledges the fact that local people and their ecological knowledge should be integrated as much as possible in the local decision-making process, but highlights the fact that certain aspects of conservation are not negotiable according to national /international laws.

In reply to the contribution of Sandra Bell on local biodiversity and conservation conflicts I would like to express that I strongly support her comments to involve the local people and their knowledge more and integrate them in the local decision making process, except for some things mentioned in the last chapter.

Here is it written:

"Regulation of commercial fishers is more acceptable, but when local people want to take fish for their own consumption they feel it is their right to do so even at times of the year when fishing in banned. This is just as true in places where people can afford to buy non-local fish as in places where the fresh water fishery is a vital source of household subsistence."

Although local biodiversity conservation in practice means negotiating different (often confronting) opinions and participatory procedures that are very much "in fashion", the example of fishing at times of the year when it is banned should be out of the question (even if it touches the self-understanding of locals). In many cases different levels of regulations for local use of biodiversity and for third parties might be appropriate, but this should be defined by certain limits. This means that local conservationists should make clear what issues of biodiversity use are under negotiations and the points that are not negotiable according to national/international laws.

As far as I know, the periods when fishing for specific fish in Europe is banned during the year overlap each other, so no one, even in areas where fish are "a vital source of household subsistence" should end up in trouble with a zero diet.

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**Biodiversity conservation and knowledge synthesis regarding structure/composition and function of biodiversity**- Jari Niemelä, University of Helsinki.
KEYWORDS: Biodiversity services, biodiversity maintenance, knowledge synthesis.
SUMMARY: The main biological resource we need to consider is biodiversity. Communication among researchers and (other) stakeholders is needed to synthesize the relevant knowledge.

The answer to the first question ‘what biological resources do we need to consider’ is ‘biodiversity’, i.e. all of them. Biodiversity encompasses all levels of biological organisation from genes to ecosystems. The concept is so broad that some writers feel that ‘biodiversity’ equals ‘nature’. Thus, an answer stating that biodiversity is the main biological resource to be considered gains general acceptance as it includes everybody’s pet organism or ecosystem. But why is it important to maintain the entire biological diversity? Because it is difficult (impossible?) to prioritise which one of the different organisational elements (structure, composition or function) and which organisational level of biodiversity is the important one (genes, species or ecosystems). Furthermore, the elements and levels are interlinked so that disruptions in one of them may cause cascading effects in others. This is another reason for maintaining all the parts of biodiversity.

Biodiversity is vital for humans. The benefits of biodiversity consist of structural and compositional biodiversity resources or 'ecosystem goods' (such as game species, timber, medicinal plants) and functional elements of biodiversity or 'services' (such as regulation of climate, carbon sequestration, decomposition, maintenance of hydrological cycles, pollination) (Christensen et al 1996). Again, it is impossible to rank these services because they are not directly comparable. Furthermore, links among them may cause indirect and unexpected effects.

Is it then a futile task to try to define the main biological resources? Perhaps it is. Maybe it is useful to define biodiversity (including structure, composition and function) as the main biological resource and focus on its maintenance. The innovation of the biodiversity concept is the realisation that, by definition, it is not only a 'target' in nature but also an inherent property of nature (Haila & Kouki 1994). This means that biodiversity cannot be maintained just by setting aside protected areas as museums. Biodiversity is everywhere and it has to be protected or maintained everywhere all the time. Nature can only provide services if its structure and composition are maintained. Thus, by maintaining biodiversity we make sure that it keeps providing its vital services to maintain itself and the humankind (as part of biodiversity).

The second question of the theme is 'how do we synthesize our knowledge to better understand the risks associated with our dependency on biodiversity?' There is a considerable amount of knowledge available about the structural and compositional aspects of biodiversity. There is less information about the functional elements, and especially about the relationship between structure/composition and function. However, even here, recent compilations and ongoing research will increase our understanding. I see two kinds of syntheses of knowledge: (1) synthesis of the scientific knowledge, and (2) synthesis of the societal applications of the knowledge. Ideally, these two processes of syntheses should go hand in hand, and I feel that fora including scientists and (other) stakeholders, such as EPBRS, are very useful for this joint work.

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**RE: Biodiversity conservation and knowledge synthesis**- Phil Lambdon, CEH Banchory.

KEYWORDS: holistic approach, herbivores, chemicals, biotechnology, information, interactions.

SUMMARY: The holistic view of biodiversity conservation may be the most beneficial approach to humans when "benefit" is also viewed in holistic terms. This is illustrated from the standpoint of the value of understanding plant ecology, their chemistry and their interactions with herbivores.

There has been a general opinion in this discussion that the value of biodiversity should not be seen solely in terms of direct human benefit. From this standpoint, a holistic approach to biodiversity conservation becomes more strongly favourable than a highly prioritized one. However, it occurs to me that the holistic route may sometimes also be the most economically-beneficial in the long-term also.

I will illustrate this with reference to an area of research in which I have been involved in the past. This research focused on the relationship between herbivores and the secondary chemicals produced by the plants on which they feed. Plants produce a dazzling array of such chemicals at great expense. They have evolved highly complex biosynthetic pathways to synthesize a wide range of subtle structural modifications, and very finely-tuned regulatory mechanisms to precisely control the location and concentration of their defences. As yet, we have very little understanding of how this effort helps to "control" the herbivores' behaviour and minimize the impact of the grazing damage sustained. But it has recently become a much more critical issue. Biotechnological advances - particularly genetic modification - have enabled plant breeders to change the types and levels of secondary compounds in a variety of crop species. Unfortunately, they have, as yet, very little idea of what they are aiming to achieve because of a lack of knowledge about the underlying biological systems.

From this, I draw three conclusions:-

(1) In the present context, the complexity of both herbivore and host interactions, in natural ecosystems, represents a wealth of one important resource - information. Only by studying systems which have adapted on an evolutionary time scale can we hope to identify adequate solutions to very modern conflicts with nature.
(2)Any loss of biological diversity will impoverish the knowledge we can gain from such systems. The information lies in the complexity of interactions.
(3)It is not necessarily only the "species-level" at which biodiversity should be conserved. Between populations there may be variations in plant chemistry which carry either important information or valuable new chemical forms which have yet to be discovered. Only an entirely holistic view can maximize the anthropogenic benefits.

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**RE: Biodiversity conservation and knowledge synthesis**- Alan Feest, Bristol University
KEYWORDS: Biodiversity assessment, taxonomic groups, macrofungi, biodiversity quality.
SUMMARY: The need for a unified approach to the estimation of biodiversity is discussed in response to the issues raised by Jari Niemela.

A very good way to stop a discussion about biodiversity is to ask people how they would define biodiversity. The conversation then continues on this latter track for some time without reaching a consensus!

Jari Niemela gives some indication of this complexity by inferring that biodiversity has structural, compositional and functional aspects i.e. it is more than a list of species. In my own research I have taken this approach and now describe the biodiversity of a taxonomic group in the following way:
- The number of species in a unit area (Species Richness)
- The evenness or dominance of the species present (Shannon-Wiener, Simpson and Berger-Parker Indices)
- The density of individuals present (number per square metre)
- The relative rarity of the species present (a calculated Species Value Index)
- The biomass of the taxonomic group present (calculated from standard reference to the size of a typical individual)

Not all of these indices can be calculated for all taxonomic groups thus biomass is not calculated when working on Bryophytes but can be for Arachnids and macrofungi. By measuring these different biodiversity qualities, an overall biodiversity quality picture is derived for a particular taxonomic group and thus by adding together the various taxonomic groups, a more complete picture for site comparison is derived. This approach is necessary for several reasons not least the need to present decision makers with concise standardised information that can form the background for objective decisions.

To be more practical, the following is an actual case: In surveying two adjacent woodlands for macrofungi we found that the modern (30 years old) coniferous forestry was far superior in all of the above indices than the ancient oak woodland (there are reasons but these need not be discussed here). This has meant that the management plan to remove the coniferous woodland and replant with oaks had to be revisited as this would remove the best macrofungal biodiversity of the site. A compromise was instigated that included leaving substantial quantities of harvested coniferous woodland on site to rot to be followed by a management plan designed to rectify the macrofungal poverty of the oak woodland.

In response to Tor-Bjorn Larsson I would therefore say that only by measuring the biodiversity qualities of as many taxonomic groups as we can will we approach a knowledge of the biodiversity quality of a site and compare it with others. This will allow us to make decisions and plans that conserve as much of the totality of biodiversity as possible.

What is now needed is the input to allow this sort of data to be collected across Europe (in the first place) so that an idea of the real biodiversity hotspots can be identified before it is too late.

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**Biodiversity conservation: choice or chance?**- Martin Sharman, European Commission.
KEYWORDS: Biodiversity values, biodiversity conservation, social choice.
SUMMARY: It may be dangerous to select certain elements of biodiversity to conserve. Human values, which are subject to fashion, are a poor guide to deciding what is needed to maintain life on Earth and what will allow evolution to continue.

I quite agree with Jari's opening statement that "The answer to the first question 'what biological resources do we need to consider' is 'biodiversity'".

Later in his contribution, however, we part company - if only briefly. He states that "biodiversity is vital for humans" and goes on to talk about the benefits of biodiversity for humans. Of course I agree with the statement, but I feel that the "goods and services" argument, however fashionable, is limited, distasteful and dangerous.

The opening words of the preamble to the Convention on Biological Diversity are: "Conscious of the intrinsic value of biological diversity." We should not lose to view this over-reaching moral reason to believe that biodiversity is something that humans should strive to conserve. This moral position - that we should try to protect biodiversity in all its aspects - would strongly reinforce Jari's principle: biodiversity should not be conceptually fragmented into "bits to conserve" and "bits to abandon".

Of course I understand the argument that nothing has "intrinsic" value, because unless humans are there to value it, nothing has value. This is a corollary of the strong anthropogenic principle, which states that because humans are here to observe the universe, the universe must have properties that make inevitable the existence of intelligent life. This philosophical position seems to me to be worthless in this argument; biodiversity existed, and creatures evolved because of that biodiversity, long before intelligent observers could argue whether anything can have intrinsic value. The intrinsic value of life seems to me to be self-evident, and if you accept that concept, then you are on morally weak ground if you try to partition biodiversity into bits that humans value (and should save) - and the rest.

Why do I think that Jari's "vital for humans" comment leads us into dangerous territory? Because by using it we can say that biodiversity only has value to humans, because only humans have value systems. Only humans can talk about the "ecological, genetic, social, economic, scientific, educational, cultural, recreational and aesthetic values of biological diversity and its components", as the CBD preamble continues. This removes the moral argument and says that we should save biodiversity because it is good for us.

But an opponent to conservation (or a proponent of development, with "sustainable" muttered through gritted teeth) can defeat each of these arguments piecemeal, or use them to select "bits to conserve".

Nobody really knows the ecological value of biodiversity - yes, some experiments show that some ecosystems function "better" (by some human value system) if they are relatively biodiverse. And of course highly impoverished ecosystems are prone to failure. But I don't think that we can defend wholesale the idea that there is a scientifically demonstrated ecological value of biodiversity.

As for things such as genetic value, well, this leads us into murky waters indeed. Should we accept that all genetic variation is intrinsically (!) good, because every stray allele might have some useful function of which we are not yet aware? Or must we argue gene by gene to show that the particular alleles we want to save have some value (to whom?). Analogous arguments apply to scientific, educational, and recreational values.

The economic argument seems to me to suffer from two other major problems. If you think that it is a good thing to conserve life in this solar system, then the total value of biodiversity is infinite. But the marginal economic value of any particular bit of it is likely to be tiny, since there is always more biodiversity around the corner. Thus no specific bit is likely to be worth preserving for economic reasons. Conservation, in general, will never pay for itself.

If we look at the economic argument in another way, we could say that the only species worth saving are those of economic importance. But to conserve them we would have to conserve their whole trophic web, which includes a good deal of invisible biodiversity -

either in the soil or the ocean, or wherever. Do we really know how to conserve specifically these species? I suspect not, in which case we have to admit that the economic argument leads us to conserving a lot of species whose economic value is unknown - and back to the view that we should aim to conserve as much as possible.

As for aesthetic values, of course we are attracted to pretty things, but don't ugly things have just as good a claim on rights to existence too?

To argue that biodiversity should be conserved for its cultural value has a good deal of merit, if you can persuade people that each species has as much (or a great deal more) complexity as the most wonderful city, and that in itself this complexity forms part of our cultural heritage. But I suspect that this is an argument that has limited appeal for many people on the planet, for whom a bug in a tree has nothing in common with their view of cultural heritage.

Finally, there is the social value of biodiversity. Here is the crux of the argument. Humans are the great agents of change, and our views of what we should do about that change depends entirely on our social perspective.

While biodiversity loss happens carelessly as collateral damage consequent on economic progress, conservation requires decisions and energy. If we destroy biodiversity mostly by inattention, we conserve it by choice. So even if the moral position is that we should try to conserve biodiversity in all its aspects, society still has to decide what it wants to conserve. In other words, society will have to decide to put energy into conservation; and that energy does not come free of cost. Cost, inevitably, implies trade-offs and compromises - something must be sacrificed. So what should society decide to conserve?

The CBD has the last word; in the end, the biodiversity that we must absolutely conserve are those aspects that are important "for evolution and for maintaining life sustaining systems of the biosphere". And what are they? We just don't know.

What scientific research is needed? I think that we need to:

· Understand the ecology of extinction - in the great extinction spasms of the past, how did the triggering event cause the collapse of biodiversity and lead to the failure of ecological systems?

· Understand the feedback between biodiversity simplification and climate change

· Understand how European societies manage the conflicts that arise when efforts to conserve biodiversity restrict economic or other human activities.

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**RE: Biodiversity conservation: Choice or chance?**- Tor-Bjorn Larsson, European Environment Agency.

In reply to the issue of whether it is justified to "select certain elements of biodiversity to conserve" unfortunately we have to make choices and set targets, i.e. how we exploit biodiversity and/or how we allocate resources to the conservation of biodiversity. Whether we state this openly or not our actions can be related to priorities.

Scientists should provide relevant information to help politicians and other decision makers to allocate resources that optimise the effects on biodiversity conservation. I think this is the background to the message by Jari Niemela. However, on a more basic and ethical level of course Martin Sharman is correct!

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**Ecological values and biodiversity conservation**- John Hutcheson, Biological Systems Ltd.

KEYWORDS: Ecological value, belief systems, buffering.

SUMMARY: The author argues that the basic functional capacities of the biosphere are observable at any ecological scale, and that in order to maintain this natural buffer system we need to change the way humans operate.

Martin Sharman made the comment, "But I don't think that we can defend wholesale the idea that there is a scientifically demonstrated ecological value of biodiversity".

I cannot agree. We have the observable facts that biodiversity (the new word for life) creates and maintains conditions suitable for life as far as this is possible on a sphere

spinning, wobbling, and whizzing round the sun. This was reported for the global scale by Lovelock some 35 years ago, with what has come to be known as Gaia theory as Lynn Margulis provided bacteriological mechanisms. However, the basic process of life buffering physical parameters is observable at any ecological scale, from a sheltered garden to the planet.

The most fascinating aspect of these "scientifically demonstrated ecological value"(s) is that the basic concept of an entity larger than man, nurturing and protecting life, is difficult to differentiate from the concept of 'God', (or the belief systems of vernacular societies). Also, of course, global homeostasis provides 'purpose to the design', thereby undercutting the basic scientific assumption (extended from the simple science of physics) that reality is non-teleological, and throwing a big question mark into all analytical scientific methodology applied to ecology.

The functional capacity (buffering) provided by the biosphere is now being threatened (as reflected in the increasing extent and frequencies of climatic extremes - just as our societal organisation makes us increasingly susceptible to being affected by them). The only prospect we have of sustaining our society is to re-extend the natural buffer systems as much as possible and as extensively as possible. We can only hope to do that if mankind can live within (and utilize) these natural systems - because we are everywhere. 20% cover of reserves ain't enough (as is apparent from an economics analogy - if you spend 80% of your capital, you are going down).

Perhaps if people saw environmental destruction as 'killing God', we might make sufficient change to the way humans operate that the planetary buffering system might continue to support our society. However, given that our population doubled from 3 billion in 1970 to 6 billion in 2000, and that this was shorter than the time required for a change in our collective scientific paradigm of purposelessness, I don't hold out much hope, do you?

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**Ecological value of biodiversity**- Martin Sharman, European Commission.

KEYWORDS: Ecological value, buffering, reasons for governance.

SUMMARY: Can we use the ecological value of biodiversity as an argument to encourage the development of policies that seek to protect biodiversity? Probably not, because the evidence before our eyes is that progressively simplified systems persist - until they abruptly collapse.

John Hutcheson believes that "there is a scientifically demonstrated ecological value of biodiversity". I would be flying in the face of reason (and evidence) to deny that life creates and maintains conditions suitable for life or that life buffers physical parameters. This is not my argument.

I suspect that our disagreement may stem from his perception of biodiversity as 'life' and my perception of biological diversity as 'a characteristic of life'. But I feel that there is another point here, to do with governance and what reasons we give in support of our belief that we must develop human survival systems that conserve biodiversity.

What concerns me is that we can take an ecosystem (for example, a forest) and progressively simplify it by removing species, or reducing biodiversity in some other way, perhaps by reducing the populations of the most common species, or removing certain phenotypes. For a long time, the buffering that John talks about means that the forest will maintain some kind of ecological integrity as this reduction in biodiversity continues. We probably all know at least one forest - or other ecosystem, the ocean being the most glaringly obvious one - that is going through this slow transformation. The loss of each single species may bring about a small cascade of other losses, but can we say that the diversity itself (as distinct from any of its components) has scientifically demonstrated ecological value?

At some point, perhaps, we will remove one species too many, and an ecological catastrophe will follow and the forest (or fertile ocean) will be transformed into something else. At that cusp, nobody could possibly deny that biodiversity has ecological value. Unfortunately we will almost always discover the phase space location of that cusp too late.

And this is my worry about such a functional reason for defending and cherishing biodiversity - we can go on pulling away the pillars from under the pier for a long time, without anything terribly dramatic happening. Anyone who tries to warn against this kind of behaviour is discounted as a doomsayer. But when the pier does abruptly collapse, what can we do except watch?

I feel that nobody should end their contribution to this conference without stating what strategically important research should be done, in support of good governance, to investigate the concerns that they raise. In that belief, here is my (partial) list of "science for good governance" for this issue:

- Understand how to define and assess ecosystem quality.
- Develop ways of managing endangered or threatened ecosystems, marginal or relict habitats, and those with low resilience.
- Understand how to evaluate the minimum area that an ecosystem must cover if it is to persist under probable scenarios of climatic and anthropogenic change.
- Understand the ecology of the deep ocean and the benthos and its response to drivers of biodiversity change.
- Develop effective low-cost methods to rehabilitate threatened species and restore degraded ecosystems.
- Last, but by no means least, better understand how to conserve biodiversity while ensuring sustainable livelihoods.

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**RE: Ecological value of ecosystems**- John Hutcheson, Biological Systems Ltd.

KEYWORDS: Unitary system, Coleoptera, trophic links, biosecurity.

SUMMARY: The author repeats his plea for inclusion of recognition of the characteristics of biodiversity at all scales and gives some reasons for doing so. He introduces some scientific heresy, redefines the questions for terrestrial systems as he sees them, provides a practical approach to answering them which is valid for NZ systems, and gives some basic information returned from use of the approach.

In his response to my urging us to include emphasis on the characteristics of biodiversity as a unitary system at the global scale, Martin Sharman focused our attention back onto our present recognition of the characteristics of biodiversity as the separate components we see when wearing our various taxonomic hats. However, we could just as easily (if we could see a reason for it, and psychologically adjust to it) characterize biodiversity as the total unified system, just as we presently characterize both the components and the totality of individual organisms. All organisms are both composites of, and components of, other organisms/systems anyway, to the extent that recognizing an “individual” requires us to close our minds to everything not defined within the taxonomic group we choose to be seeing. Although the term biodiversity attempts to move us toward a broader appreciation of the biosphere, it has been co-opted by a numericist industry that attempts to understand ecology through e.g., 'diversity indices' that ignore the core subject of the biological attributes of the components.

Obviously we will continue to characterize the biosphere in terms of species as these lifestyles represent the various ecological pathways and networks we are attempting to understand. And without such a classification we cannot communicate. We already use the finer scale of genotype in agriculture and conservation, and the larger scale of system level currently drives some policy. But what are the practical gains from an adjustment of our perception to include life at the largest global scale?

Well, it is much simpler to make a strong case that high biodiversity is important when we are contemplating a whole rather than just subsets. Although some natural subsystems function well with apparently low diversity, if we perceive the larger scale we can more easily appreciate the role of diverse genotypes as providing contingency pathways within a variable environment. We can also better appreciate them as functional components of the properties such as global environmental stability, which become emergent at the larger

scale. We can thus more easily appreciate that any loss - is a loss of contingency provision. Although this lost potential cannot be experimentally measured, any loss represents a direct threat to the long term, larger scale, environmental stability that our societal structures have become globally dependent upon. The more holistic point of view gets us away from arguments about how much of the patient's body can be surgically removed before death, and better reminds us that we are the patients.

Not emphasizing the whole may also narrow our perception of the tools available for remedial measures. For example, it is quite possible that a spiritual appreciation of biodiversity could better win the hearts and minds of all folk over to the necessary task of conservation of this miracle of life (note that there are no known laws of physics which say that life should arrange itself in this manner (Davies 2002)), than science could ever manage. Every hardnosed, agnostic scientist I know who has worked in natural systems has experienced exalted moments of appreciation of the beauty of life. But this tends to happen when sitting down having lunch and contemplating the whole, rather than when one is busily counting body parts.

If we see life as a complete system we can also better appreciate that biodiversity provides the environment for all species in the system, i.e. the 'environment' of all organisms IS their biotic community. The physical environment that we as scientists measure so assiduously is separated (buffered) from the organisms by the biotic community itself. The loss of any genotype is therefore likely to impinge on the environmental requirements of the remainder of the community, particularly as current understanding suggests that this would lead to less moderation of fluctuations in the physical environment. As we know, when their environmental requirements are not being met, species cannot persist and so the species-loss effect of physical fluctuations within say forest fragments would be expected to accumulate as community change over time, eventually leading to our recognition of system change at the larger scale.

As an aside, this broader perspective also more easily enables us to appreciate that it is the surrounding biotic community that directly selects the fittest subunits - and therefore that evolution is directed by the community (Just to introduce a little heresy into the religion of science).

Once we realize that biodiversity provides both detail and context for our society, the 'better question' becomes 'how does our planetary management affect biodiversity?' This question drives us to seek information at two perceptual levels. The first is local systems as the land manager perceives them, i.e., vegetation. These systems are already being mapped using GIS technology for large areas of the world. The scale and accuracy is continually being refined, but eg., New Zealand already has a mapped conservation hierarchy of ecological regions and districts, and within these, areas of conservation interest. Vegetation systems of the economically productive landscape are also very well documented. However, live vegetation represents current production, while most of biodiversity is involved in retention of past production within the system.

So what we are sadly lacking are the links between the systems we see, and the characteristics of the biodiversity they are comprised of. Because different species have different environmental requirements, no taxonomic group of limited membership and system presence can be used to infer the characteristics of biodiversity in the broader community (Eg. you can't learn much from shark communities in a desert). This directs us toward the largest section of biodiversity (and the total dominants of terrestrial biodiversity), the insects. Not just as taxonomic lists, but as lifestyle networks to illustrate the linkages between biodiversity as 'characterized' at the scales of communities of species and individuals, and the systems recognized by the land managers.

Within the insects, beetles appear to provide about half the species. Therefore any indicator (such as vegetation), which has not first been 'calibrated' against beetle communities cannot claim to represent biodiversity. The extremely diverse range of lifestyles within Coleoptera communities can provide us with functional (eg. trophic) summaries of what each vegetation system type and dynamic represents in terms of its biodiversity 'characteristics'. These may then guide us in our management of the vast areas of the globe that are currently

managed as though land was a simple physical commodity rather than a global biological entity.

The message from NZ beetle community samples is that biodiversity represents the jobs needing to be done in the system. Thus beetle biodiversity is vital for forest carbon recycling, and wood to recycle is vital for beetle biodiversity. It is instructive that use of vegetation alone as an indicator would exclude our rapidly growing exotic (for NZ) pine plantations from consideration of endemic biodiversity. However beetle community samples show they contribute a vast amount to the retention of indigenous NZ biodiversity (Hutcheson and Jones 1999). The extremely rapid carbon acquisition and turnover in these systems is reflected in much higher species richness and abundance of (almost all endemic) species at the local site level than found with native vegetation systems on similar (pumice) soils (Hutcheson and Kimberley 1999). However, over the larger spatial scale (in terms of both area and structure), sample composition reflects the much greater homogeneity within plantations. This accords with the obvious fact that landscape diversity is necessary for the retention of associated biodiversity as characterized at the species level.

Samples from sustainably managed private indigenous forest, reveal beetle biodiversity to be enhanced by limited forest disturbance (as this provides the recycling resource), and thus that a policy of judicious utilization is therefore not anathema to biodiversity (Brooks 2001). This latter finding is to be welcomed because in order to attempt to slow the loss of global climatic buffering, we need to radically and rapidly enlarge natural forested areas. Because humans are everywhere, to do so we will need to live amongst them and utilize them.

NZ has locally endemic species wherever sufficiently skilled people have looked (e.g. Kuschel 1990). However there is still separation of the conservation and utilization lobbies in this country. Neither lobby seems yet to comprehend that we cannot afford such separation, that conservation must be global or human society loses - probably in the short to medium, rather than the long term. This therefore means that while we must extend and utilize natural systems, all our utilization processes and systems must be scrutinized for their relative destructiveness (or otherwise) to the components of biodiversity. The only way to do this is to examine the heart of biodiversity (the beetles) within our land management systems using a standardized sampling system. A national (or international) coordinated approach to such work would have major positive spinoff for ecological understanding, biodiversity conservation and biosecurity (in the agricultural sense rather than the paranoid American one).

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**Biodiversity and biophilia**- Allan Watt, CEH Banchory.

KEYWORDS: Biodiversity resources, conservation, biophilia, biodiversity dependence.

SUMMARY: Although research on the conservation of biodiversity should be regarded as a priority, we also need research on our dependency on biodiversity as a supplier of biological resources, in the widest sense of the word. It is argued that we have neglected some of the intangible resources that biodiversity provide, and that, in particular, we have neglected the benefits of the human bond with biodiversity.

Andreas Troumbis asks us "what main biological resources do we need to consider… to better understand the risks associated with our dependency on biodiversity?"

At the start of this e-conference, I wondered how much the participants would focus on the tangible biological resources that biodiversity provides us. In the first couple of days we did, indeed, focus in detail on one, very tangible, resource, food. However, the discussion then switched to powerful arguments, from Jari Niemela and Martin Sharman, to consider, and conserve, all of biodiversity.

I agree with the principle that we should conserve all of biodiversity for its own sake and irrespective of the goods and services that it provides. Martin Sharman feels that the "goods and services" argument is distasteful and dangerous. I agree but only insofar as the use of this argument as the primary reason for conserving biodiversity. However, we also need to consider the biological resources that biodiversity provide. We are truly dependent on

biodiversity and science should address this dependency, the topic of this e-conference, although not to the detriment of research on conserving biodiversity.

The discussion in the e-conference has made me think about the extent of this dependency, particularly the tangible resources that I referred to above. There is a long list of such resources, including the food that we eat, the clean water we drink and the clean air we breathe.

But what of the other, less tangible resources that biodiversity provides. I hesitate even to refer to them as resources because I suspect that we can all live without them. These "resources" are provided by plants, animals and landscapes; they are what I see, hear and smell. They are also what I know to exist but have never seen and will never see. They are even what I imagine to exist. What they provide is difficult to describe, particularly for a scientist trained to be quantitative. So I'll quote E.O. Wilson:

"…I stood in the Arawak village of Bernhardsdorp and looked south across the white-sand coastal forest of Surinam. For reasons that were to take me twenty years to understand, that moment was fixed with uncommon urgency in my memory. The emotions I felt were to grow more poignant at each remembrance, and in the end they changed into rational conjectures about matter that had only a distant bearing on the original event. The object of the reflection can be summarised by a single word, biophilia, which I will… define as the innate tendency to focus on life and lifelike processes."

Wilson then devotes the rest of his book Biophilia (published by Harvard University Press in 1984) to "the human bond with other species". Wilson is, of course, better known for promoting the word "biodiversity" (although not inventing it) and I rarely hear biophilia being mentioned. But as I stare at the cover of my old copy of the book and read the words quoted above I remember my "Bernhardsdorp" moments. Indeed, I recall the strength that experiencing biodiversity has given me throughout my life, wherever I am, from watching (and being watched by) gibbons in primary forest in Sumatra to the screams of swifts in our cities, towns and villages, a sound I eagerly await every year.

Am I - are we - dependent on biodiversity in this way? I am not sure but, at the risk of offending some other participants in this e-conference, I would argue that the human species is more dependent on biodiversity in the way that I struggle to describe above than in the diversity of cheese.

If it is true that we are dependent on biodiversity in this way, it is, I think, another argument to support the view that we should conserve all of biodiversity. In this respect, I support Martin Sharman's list of research needs, and would add a few more.

However, I also support the view that we need to understand better how biodiversity supplies the resources that we are dependent on. Andreas Troumbis listed several areas of research and others have been discussed. I strongly support his call for research on the role of biodiversity as indirect and dynamic mediators of ecosystem services. However, this research must be practical. To quote Jari Niemela, we need research to "make sure that [biodiversity] keeps providing its vital services to maintain itself and humankind".

And surely we need to understand better the human bond with biodiversity. Are we dependent on it? Why are we dependent on it? What difference does it make to us? What aspects of biodiversity particularly drive this bond?

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**RE: Biodiversity and biophilia**- Rainer Muessner, CIMAR.

KEYWORDS: Biodiversity resources, conservation, biophilia, quality of life, environmental education.

SUMMARY: The author agrees with the importance of biophilia as a factor for conserving biodiversity and stresses the need to improve the methodology and effectiveness of environmental education.

I very much like Allan's contribution that brings the discussion to that very difficult field of intangible values of biodiversity and the 'human bond with other species', called biophilia.

He mentioned correctly that biophilia (as a word or concept) is not very well known. Some research done more than 10 years after Rio has shown that less than 20% of people have heard about biodiversity or could explain (very roughly) what it is. If it is difficult to bring a concept such as biodiversity to peoples' minds, even with some strong arguments in fields that are tangible like processes and services (see earlier discussion), discussing biophilia with people on the street is even more difficult. Biophilia sounds very 'philosophical', even if people still have the 'human bond with nature'. Even so it is a very important point in the chain of argumentation as to why to protect biodiversity.

To get the concept across to peoples' minds (and feelings of course) it might be useful to link it to another term that is very well known in all classes of society and that is 'quality of life'. For some people, quality of life is only defined by the number of holidays they can afford per year or the distance to the next shopping centres, but listening to the screams of swifts also belongs to the quality of life of a lot of people. It is then a question of whether people are aware of that fact, or if there are persons that make them aware (i.e. some kind of environmental education).

Environmental education is too often seen from the scientific point of view as practical nature conservation work and not understood as a subject for research. But scientific research is needed to improve biodiversity protection in the long run. It is my strong belief that peoples' attitudes (and the adjusted value systems) concerning nature in general and biodiversity in particular play a central role in biodiversity conservation.

To pick up Martin Sharman's call not to end a contribution without commenting on the strategically important research topics I would like to add to his list the need for research to improve the methodology and effectiveness of environmental education to mediate the concept of biodiversity.

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**Conserving biodiversity with, or from, humans?**- Erling Berge, Norwegian University of Science and Technology and Centre for Advanced Study

KEYWORDS: Intrinsic value, protected area, human dynamics.

SUMMARY: The question of how humans count themselves as part of biodiversity will have profound implications on conservation. Two approaches are discussed: setting area aside for protection and reforming attitudes towards nature.

Being a social scientist I have a fairly simple view of biodiversity. The current, somewhat philosophical, discussion of the value of biodiversity is interesting and prompts me to raise a question I have wondered about from time to time: To what degree are humans counted as part of biodiversity? To me it seems that the answer will have profound implications for how one goes abut conserving biodiversity. These implications will be independent of the answer to the question of intrinsic value or value only for the mind.

The question is of course rethorical, but not only: the history of nature protection is largely a story of how to keep people away from the protected areas, and if not, how to minimise their impact on the area. I do not think that is an approach that can be taken much further in my part of the world.

There is of course another approach: reforming the motivations of people using nature. But educating people to understand the value of biodiversity will not be sufficient. Understanding the complex dynamics of self-governing communities and societies is a task just as difficult as understanding the complex dynamics of biodiversity. And the two tasks have to be solved together.

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**RE: Conserving biodiversity with or from humans?**- Kajetan Perzanowski, Polish Academy of Science.

In reply to the question raised by Erling Berge : "To what degree are humans counted as a part of biodiversity?" I would like to point out that at least in contemporary Europe it is almost impossible to find a habitat, landscape, eco-region or any other large-scale biological

system in pristine condition. In practice all 'natural systems' in this continent have been altered by direct or indirect human influence, of course to various degrees. In many cases human-related transformations have contributed to a higher biodiversity e.g. small scale agriculture will have higher diversity than a plain steppe, or a patchy forest will be more diversified than a closed canopy climax stand. Therefore, when evaluating biodiversity, the human component should always be taken into account.

Regarding the concept of nature protection as a passive 'keeping people away from protected areas' I think that it is already high time to make more common and better use of the concept of Biosphere Reserves where the human component is considered to be an essential component of the system, and the approach to nature conservation differs among particular zones of the Reserve.

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**Consequences of biodiversity loss for ecosystem processes and services**- Michel Loreau, Ecole Normale Superieure.

KEYWORDS: Biodiversity, ecosystem functioning, species functional complementarity.

SUMMARY*:* Biodiversity loss will have significant impacts on ecosystem functioning and ecosystem services; these impacts need to be known to assess their long-term socio-economic consequences.

The relationship between biodiversity and ecosystem functioning has emerged as a central issue in ecological and environmental sciences during the last decade (see recent syntheses in Kinzig et al. 2002; Loreau et al. 2002). Increasing domination of ecosystems by humans is steadily transforming them into depauperate systems. Because ecosystems collectively determine the biogeochemical processes that regulate the Earth system, the potential ecological consequences of biodiversity loss have aroused considerable interest.

Recent experimental and theoretical work in this area has shown that the productivity and nutrient retention ability of grassland ecosystems are adversely affected by loss of species and functional diversity. The main mechanisms responsible for these effects are functional complementarity among species with different ecological niches and regional stochastic processes involved in community assembly. Although the significance and implications of these mechanisms have been debated, it has now been clearly established that functional complementarity among species drives most of the biodiversity effects observed in recent experiments. Other studies have provided similar conclusions for other systems, but the nature and extent of biodiversity effects on ecosystem processes are dependent on the ecosystem and the process considered.

These short-term, small-scale experiments are likely to underestimate the true extent of the functional impacts of biodiversity loss. First, there is theoretical and experimental evidence that the diversity of functionally similar species can also buffer ecosystem processes, and hence provide biological “insurance”, against environmental fluctuations. Second, heterogeneous environments are best used by an array of species with different specialisations, and habitat destruction and fragmentation may prevent appropriate dominant species from being recruited in each community. The larger the temporal and spatial scales considered, the higher the diversity that is likely to be needed to maintain particular ecosystem processes.

Recent scientific advances support neither the catastrophist view that the biosphere will collapse as a result of biodiversity loss, nor the optimistic view that nature can be further despoiled without any consequences for human societies. Changes in biodiversity will have significant impacts on the functioning of natural and managed ecosystems, and thereby on the services they provide to human societies. These impacts need to be known to assess their long-term socio-economic consequences. How much biodiversity loss we are willing to accept, however, is a societal choice.

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**The need for a synthesis of ecological knowledge and global research networks**- Klaus Henle, UFZ.

KEYWORDS: Biological resources, knowledge and human risks

SUMMARY: I argue that we need to follow the steps of taxonomic organisations and develop information systems that synthesise in a systematic way our knowledge about the biology/ecology of species and their relationships to humans and about ecosystem services of biodiversity. We need to expand efforts to form networks developing and jointly executing strategic research programs on major biodiversity issues.

The concern about the serious loss of biodiversity has spurred not only the development of Biodiversity Conservation Strategies at the supra- (e.g. EU) and national levels, but has also greatly contributed to the stimulation of research interest in biodiversity. It has become clear that humans depend on biodiversity for various reasons and that there is a risk for humans associated with the loss of biodiversity. Nevertheless, it is often difficult to establish a direct link between human welfare and biodiversity and the adverse consequences of the loss of biodiversity for humans differs among biological resources. Also, much information about biodiversity and its relationships to humans remains hidden in the vastly expanding published and unpublished literature.

Whereas the taxonomists are meanwhile well on their way to summarise basic taxonomic (and faunistic/floristic) information and to make it available in networks of information system, there are no systematic attempts as yet to develop databases on ecological characteristics of species or the relationship of particular biological resources to human interests and to link this information to basic taxonomic and floristic/faunistic information systems. Therefore, I argue that we urgently need to start a concerted effort to develop such a synthesis and to make it broadly available. This challenge and its importance for humans is no less than the one addressed by the Human Genomic Project and should obtain the same global support.

However, biological resources are not only relevant for humans on the level of species. Biodiversity is the very basis of ecosystem services to humans and their dysfunction also entails risks for humans. Often microbial and other neglected organisms play a major role in such services. Therefore, research on ecosystem services and functions of biodiversity as well as on the main drivers of biodiversity loss and their impacts need to be expanded and synthesised as well. Such research, e.g. assessing the effects of particular drivers on biodiversity and the consequences for humans often cannot be tackled by small groups of research organisation alone. Therefore, we need to develop global networks of research groups that join their efforts to address such issues in a systematic way. The EPBRS, PEER (Partnership for European Environmental Research) and other European networks should play a pivotal role in the development and implementation of such strategic biodiversity research and in the synthesis of the results for biodiversity action programs. Subgroups could take responsibility for selected topics such as biodiversity and habitat fragmentation or climate change and biodiversity.

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**Biodiversity conservation and eco-regions**- Kajetan Perzanowski, Polish Academy of Sciences.

KEYWORDS: Biodiversity maintenance, biological organisation, biological resources, eco-regions.

SUMMARY: Since the maintenance of biodiversity through protection of selected components of the biosphere is not effective, I suggest an introduction of eco-regions as basic units for biodiversity conservation.

It has been already said in earlier contributions (Jari Niemela, Martin Sharman) “biodiversity encompasses all level of biological organisation, biodiversity equals ‘nature’, aspects important for evolution and maintaining life sustaining systems..." which implies that maintenance of biodiversity requires protection of all aspects of life within the planet.

In practical terms, this means that protection of selected "bits to conserve" (again Martin Sharman), though not harmful, does not make much sense, since our criteria on what is important and what is not are changing in time, and are obviously different for various countries, economic systems, cultures etc.

Therefore, if it is impossible to maintain the entire biological diversity, and to prioritise among organisational elements of the biosphere (again Jari Niemela), the only reasonable solution seems to conserve biodiversity within functional units that encompass all levels of biological organisation from genes to the landscape, and include all biological resources at regional level.

Here comes the concept of an eco-region, as a unit being functionally homogenous in ecological sense, where all levels of biological organisation are represented. Considering inevitable changes resulting form the evolution of the living world, protection of an ecoregion as a whole, would allow maintaining not only its structural components but also processes essential for sustainable functioning of this system.

The task for science would be then to identify and delineate the network of eco-regions in the scale of the planet and determine what is indispensable for securing their further existence.

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**RE: Biodiversity conservation and eco-regions**- Christian Kleps, Academy of Agricultural and Forestry sciences.

KEYWORDS: Eco-region, Balkans, natural elements, environmental agreements.

SUMMARY: The author agrees with the concept of eco-regions as basic units for biodiversity conservation by discussing the issue of transboundary pollution in the Balkans. However he also points out that eco-regions should encompass other natural elements and the role of existing environmental agreements in establishing eco-regions.

I totally agree with the concept of eco-regions proposed by Kajetan Perzanowski as a possible solution for a sustainable conservation of biodiversity, including all biological resources at regional level. As an active member of the Balkan Environmental Association I have noticed in these last years the many common problems we have in the Balkan countries regarding transboundary pollution, many of them being related not only to our geographic neighbourhood, but also with our similar economic systems, traditions, culture, etc.

However, here I feel the difficulty to identify and delineate the network of eco-regions at the planet scale only "as units being functionally homogenous in ecological sense". There are other natural elements like a big river, a sea or a mountain chain, which also deserve to be taken into consideration, because they connect countries through common economical, and ecological interests, such examples are the countries included in the International Convention to Protect the Danube River, the conventions and agreements for the Black Sea countries, for the Mediterranean countries and so on.

In this respect I want to emphasize the importance of taking into consideration the existing environmental agreements between countries from a particular area, for establishing an eco-region. It is also very important to consider and take advantage of the achievements obtained from applying all international conventions related to environment and biodiversity, for all the future project proposals in relation to biodiversity (the synergy).

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**RE: Biodiversity conservation and eco-regions**- Kajetan Perzanowski, Polish Academy of Sciences.

KEYWORDS: Eco-regions, natural features, environmental agreements.

As a comment to Christian Kleps' contribution, I would like to explain that natural features like mountain chains, riparian habitats along rivers, estuaries, wetland areas etc are an eminent component of the eco-region concept. Such areas should be perceived as a unit and subsequently managed/protected in a consistent way.

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**Wrong question**- Jurgen Tack, Belgium Biodiversity Platform.
KEYWORDS: Biodiversity, dependency, risks, benefits.
SUMMARY: It would be wrong to try to understand the risks associated with our dependency on biodiversity. The risk of being dependent on biodiversity is simple: if biodiversity disappears, we disappear. But is there an alternative?

How best to synthesize our knowledge to understand the risks associated with our dependency on biodiversity? When I first read this question I tried to analyse the question and came to the conclusion that there is a more important question.

Biodiversity is defined as the variation in life forms and expresses itself through genetic, population, species, communities, ecosystems and landscape diversity.

Biodiversity is very important because of the environmental services, which derive from it and because of its multiple uses: biological diversity provide our food and natural fibers. The water we drink and the air we breathe are linked to natural cycles with high dependency on biodiversity, the productive capacity of the soil depends on its biological diversity and many other environmental facilities on which our survival depends. From a biological perspective, diversity is vital because it allows the human population and other species the possibility of adapting to environmental changes. Biodiversity is also the world's foremost biological asset and presents critical options for its sustainable development.

We do not have a full understanding of the processes involved in all those aspects of biodiversity! One of the major problems is our limited ability to integrate our research on biodiversity into one global picture in such a way we still understand what is happening.

This is a rather egocentric view on biodiversity. Human beings are not the only species that depend on biodiversity. Besides us an enormous amount of organisms depend on that same biodiversity. Who are we to decide what kind of biodiversity we want to protect?

Being dependent always implies a risk. Can we understand the risks of our dependency on biodiversity while we still do not understand biodiversity? If we would understand those risks, our human nature would start seeking to minimise those risks. This would implicate trying to be less dependent on biodiversity. Look around you and try to find one item that could be made without the involvement of biodiversity. You will not find one. Our products are made with biodiversity, and more importantly by a piece of biodiversity: the human being.

Synthesizing our knowledge to understand the risks associated with our dependency on biodiversity can be summarized in two words: understanding ourselves.

We do not have to understand the risks associated with our dependency on biodiversity, we just have to admit we are dependent on biodiversity.

The more important question is: How best to synthesize our knowledge to understand the benefits associated with our dependency on biodiversity. But maybe the answer is the same.

**Session 2**- How can science benefit from or contribute to local knowledge, ethnobiology and local culture, and how can biodiversity science contribute to technological approaches, Intellectual Property Rights (IPR), fair and equitable access and benefit sharing?

**Comments on session 1 and introduction to session 2**- Andreas Troumbis (E-Conference chair), University of the Aegean.

KEYWORDS: Valuation, utilitarian argument, Biophilia, biodiversity functionality.

SUMMARY: The author discusses why the flaws of the philosophical structure of the valuation system for biodiversity used by modern scientists were made obvious during the first session of the e-conference, and addresses the issue of the utilitarian argument when conserving biodiversity. Finally the author discusses the term biophilia and its implications for biodiversity conservation.

Although not directly addressed or explicitly formulated, the 'utilitarian argument' for biodiversity preservation was at the heart of the debate during the first week of the e-conference. This was the immediate consequence of the fact that we tried to link 'biodiversity', i.e. an inherent attribute and quality of life, to the concept of 'biotic resource' that introduces the dimension of use and of benefit for humans. I am not sure that the debate explored the potential and limitations of this specific link, but I am convinced that it was successful in revealing fundamental flaws and shortcomings in the philosophical structure of the valuation system for biodiversity adopted by modern scientists. The striking element is that although the question of valuation of 'life' sensu lato has been central to civilisation since its earliest steps, modern science introduces concepts and systems apparently uncoupled from longstanding philosophical solutions to the deepest introspection of human beings. However, the question of valuation of 'life' is indivisible from the question of Ethos, Paideiai and conscience. It has been addressed, within our western tradition, from classic philosophers and early Christian theologians to 20th century humanists. It is worth remembering that the Logos of natural scientists to study the living world, in the typical Bacon-ian tradition, was oriented towards its severe exploitation in favour of humans.

Having the above in mind, I will try to present some critical points regarding the debate of last week, in an attempt to appeal in favour of embodying or connecting the theoretical discourse on biodiversity values in the fundamental philosophical debate.

From this point of view, the debate on 'potential and risks' of biotic resources was flagged by two strong positions:

- An attempt to 'compare' the various values and benefits of preserving biodiversity on a moral ground;
- A rejection of the idea of conserving only those elements of biodiversity that humans identify as procuring tangible biological resources.

It is interesting to notice that almost all contributors agreed on the second point. However there are significant divergences regarding the first point, mostly at the level of the method used and the differences in perceiving the utilitarian argument. It is widely accepted that the values of biodiversity are of scientific, aesthetic, ethical, economic and utilitarian order. Ethical values are related to the belief that humans have a moral responsibility to be stewards of the natural environment and protect all species. Aesthetic values are related to the idea that landscapes and wild species provide amenity to the public. Both 'build' the immaterial human 'bond' with biodiversity that has been eloquently described by Allan Watt. On the other side, economic values are important as known species, as well as yet unidentified ones, may provide valuable food, fiber, drugs or other products for human use. Is it worth, in our post-modern society, comparing and grading these value systems? I believe that this is strategically wrong from the point of view of biodiversity preservation. Firstly, because we do need a large spectrum of values to reach and attract the various human groups that are motivated by different interests. Secondly, because if we indeed try to put these value systems on a scale, we will inevitably face the question of criteria used for that purpose. On a moral ground, economic or utilitarian arguments may appear 'distasteful and dangerous', as

Martin Sharman pointed out. On a cynical business or politician's ground, 'human bond' may appear parochial and stupid…

Besides the methodological problem, confusion smoulders regarding the utilitarian argument: it seems that it is perceived as a synonym of economic values of species. That is totally wrong. The utilitarian argument is related to the ecosystem integrity and the functional role of biodiversity. Diversity must be maintained in order to preserve critical ecosystem services and the integrity of the Earth's life-support system. In our real world, where the environmental problem sensu lato is socially constructed as a mixture of uncertain scientific evidence, 'low' and/or 'high' level politics, ideology and variation –in time, space and social resolution- culture, aesthetic and ethical arguments are either accepted as overriding principles or discarded as unimportant. The utilitarian argument, properly presented, could be convincing to large parts of the society and could make biodiversity a much higher priority issue than it currently is. To make it strong there is one prerequisite: demonstrate the quantitative relation between losses of biodiversity and losses of function.

Special attention should be paid regarding Wilson's concept of 'biophilia'. It is a good example of philosophical discontinuity that potentially creates more problems than those it supposes to address. Biophilia comes from the greek Bios, life, and filia, propitious inclination towards something. Consequently, it is supposed to mean 'love for the living world'. However, there are problems with the word and the concept.

Firstly, the semantic inadequacy of the term: the word filia has a totally different connotation according to its place in composite words. When filia is used as a prefix, it gives to the word a positive meaning: e.g. philo-sophy, philo-logy, philo-patry etc. On the contrary, when used at the end of the word, it gives a rather negative connotation: e.g. hemo-philia, pedo-philia etc. Anyway, very few can claim being able to reach T. More's perfection with Utopia. Furthermore, since the early centuries AD, the word Zoe has semantically replaced Bios, because it powerfully merges the concepts of 'life' and 'existence'. Bios is limited to anthropocentric connotations: e.g. bio-graphy or … biotic resources. Although I consider 'biophilia' as a non-necessary concept, at least we should replace it by 'philozoia'. It is like 'automobile': obviously this thing should be called either 'ipso-mobile' or 'auto-cinete', but in this case it was just an illiterate engineer who suggested the word…

Secondly, I always wonder about the need to coin supposedly new concepts, a process that inherently contains risks of erroneous structure and of discontinuity with philosophical treatments that certainly cover its supposed domain of applicability. Major philosophers have formulated the spirit of 'Philo-zoia', in an admirable way, as the essence of conscience. Remember Donne, Humbold, Jaeger… But mostly remember A. Schwaizer who defined the object of conscience as the understanding that 'I' am life who wants to live surrounded by life who wants to live. The affirmation of life is a spiritual act of man who starts to respect life giving it its real value. But, then he feels the need to manifest the same respect to any other desire for life, (man, animals, plants etc) and therefore he reaches the absolute principle of moral and the essential axiom of conscientious thinking.

Thirdly, 'biophilia' is expected to have a certain success among a restricted and informed scientific community since it builds upon a successful scientific construct, that is biodiversity, aiming at rejuvenating the 'traditional' discourse on nature, life and environment. But, is introversion what we really need? In our effort to propagate the message for biodiversity preservation we should use a common conceptual platform with other disciplines and the general public. If I have to choose between Schwaizer's conscience and Wilson's biophilia, no doubt exists in my mind. I will always teach my students the 'Theory of Island Biogeography' as long as I do this job, but I will always speak to my children about conscience. They will understand…

In the second session of this e-conference, we will be considering how science can benefit from or contribute to local knowledge, ethnobiology and local culture, and how biodiversity science can contribute to technological approaches, Intellectual Property Rights (IPR), fair and equitable access and benefit sharing.

**Discussing biodiversity in public**- Caspian Richards, Macaulay Institute.
KEYWORDS: public dialogue, intrinsic value, utilitarian and normative arguments.
SUMMARY: The topics of the second session invite us to consider how scientists working on biodiversity can participate in a wider public dialogue with, to take two examples from the list, people who live in particular places ('locals'), and commercial interests. In this contribution I consider how the two rhetorical strategies emerging from the first section, utilitarian and normative arguments, might be used by scientists to engage with the wider public, and how each influences the kind of dialogue that might take place.

In parallel with the debate about whether it is proper to argue for biodiversity conservation on utilitarian grounds (thanks to Andreas for giving this cluster of arguments its rightful name), or whether we should argue only from normative grounds (i.e. on the basis of its intrinsic value), similar concerns are also to the fore among those concerned with human development. As Erling has pointed out, nature conservation has only very recently begun to consider human welfare as part of the equation, and those interested in human welfare often seem to find themselves debating with conservation organisations the practical benefits for conservation of taking human concerns on board (i.e. a utilitarian argument), rather than the intrinsic value of human welfare.

Considering these two types of argument - the utilitarian (i.e. that the thing we are seeking to justify is good for something else) and the normative (i.e. that it is good in itself)- helps us to think about how dialogues between biodiversity scientists and other groups do and might work in practice. Martin has highlighted the important point that to someone who sees intrinsic value in something, discussing its utilitarian value seems to be disrespectful at best, and at worst counter-productive. After all, if the argument for biodiversity conservation stands or falls on whether economists can be persuaded to include enough intangible factors to swing the sums in the balance of biodiversity, then it is on shaky grounds. Different studies will inevitably produce different results, which tends to lead to people citing the ones that suit them and ignoring the ones that don't.

I think it is right, therefore, to focus predominantly, as many contributors have done, on communicating exactly what it is about biodiversity that they find intrinsically valuable, in the hope that other people will come to see it too. The wider success of this approach is, I feel, severely hampered by a reliance on the term 'biodiversity'. I recognise the benefit that the coining of a new word has had as a rallying call to ecologists to think more holistically; new words can also, as this one has, excite policy-makers and open new avenues of funding, another significant factor in their favour. However, Rainer has pointed out that less than 20% of today's population have heard of the word - frankly I am surprised it is so many. I suspect that as a rule we enjoy new words when we have a hand in creating them or contributing to the discussion of their meaning, but that when they are presented to us as already determined artefacts then they tend to be alienating. The term 'buzzword' has (or perhaps has come to have) a pejorative side which captures the outsider's frustration.

Finding an alternative way of expressing to those not in the know what it is that we want to conserve and why is not only essential to establishing wider communication, but is also, I would like to argue, where scientists will benefit most from and contribute most to other people's knowledge. As Andreas has pointed out, people have been discussing the intrinsic value of life for millennia. They continue to do so around the world today, and I suspect that one of the reasons that 'science' and 'society' are now seen as separate entities is because most scientists shy away from spiritual discussions of this kind in favour of a drier in-house discourse. Nevertheless, we have seen in a number of recent posts that both the susceptibility to and ability to communicate the appreciation of the intrinsic value of nature is very much there in at least this subset of the scientific community - all that is needed is surely for people to do it more often, and to find occasion to learn from parallel experiences expressed in non-scientific language by people who appreciate the natural world.

By way of a final point, the kind of argument one uses is not merely a question of effectiveness. Various social scientists have shown that we have many different ways of reasoning, the choice of which can be heavily context-dependent. In other words, if one

argues that biodiversity is economically important, people will be more likely to think about it as an economic resource; argue that the variety of life is sacred and people will be more likely to think about it in terms of intrinsic value. References of studies exploring this kind of distinction are available on request, but for the moment I think I've outstayed my word count.

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**Local knowledge - a clash of cultures?**- Martin Sharman, European Commission.
KEYWORDS: Biodiversity knowledge, indigenous and local people, scientific sensitivity.
SUMMARY: We are likely to be interested in utilitarian aspects of local knowledge, and these aspects are likely to be the very ones that the owners of the knowledge would like to protect.

When we speak of local biodiversity knowledge, it is probably mostly the utilitarian (thanks Andreas) aspects that interest us - and within the utilitarian set, mainly that knowledge that relates to food or medicine. It is unlikely to be for normative reasons - after all, we, the rational scientists, are not likely to belong to "their" culture, and our interest in some exotic value system is likely to be at best academic. Caspian Richards has put his finger on an essential issue when he says that "if one argues that biodiversity is economically important, people will be more likely to think about it as an economic resource". This is typically the view of the industrial world - you and me. Caspian continues "argue that the variety of life is sacred and people will be more likely to think about it in terms of intrinsic value", and this, I think, is very often the view of societies that live closer to nature.

For this reason, I don't think that it is simple to benefit from local knowledge. The burden of cultural perspective is significant. In the previous session Erling Berge pointed out that our approach to conservation depends greatly on whether we view humans as part of, or outside nature. European cultures have a long history of "struggle against nature". By contrast, the exploitation ethic of industrialised peoples is anathema to the many indigenous peoples who view themselves as an integral part of nature.

I slipped the word "indigenous" into the previous sentence. I understand by "local" two different groups. Indigenous peoples are populations that are genetically, phenotypically, linguistically and culturally distinct from peoples who moved into the area or surrounding areas at some later date. Some populations who also maintain traditional lifestyles are genetically, phenotypically, and often linguistically similar to surrounding populations, and share common ancestors with them. These are local communities, but not indigenous peoples. The reason that I make the distinction is that the responsibilities of the scientist and the policy maker towards the two groups are, I think, different.

The knowledge of indigenous peoples is a vital part of their ethnic culture, and gives them an identity that distinguishes them from their neighbours. By contrast, that fraction of the knowledge of a local community that is truly local is unlikely to be a significant part of their total cultural identity.

Thus the marginal value of local knowledge is likely to be quite different in the two cases. The preamble to the CBD (unfortunately in my view) elides the two when it speaks of "the close and traditional dependence of many indigenous and local communities embodying traditional lifestyles on biological resources ... and the sustainable use of its components." Perhaps because I grew up in Africa, I'd like to focus particularly on indigenous knowledge.

In the case of indigenous peoples, it seems to me important that researchers recognise that the traditional knowledge of biodiversity that they are studying is an intellectual property, even if it is not legally protected as such. As always, researchers should understand and respect their ethical responsibilities towards their subjects, but in this case they should also be aware that the information they gain has cultural value, and protect the knowledge if asked to do so. Many indigenous peoples are suspicious of the motives of scientists, since they have seen (or heard of) cases where patents have emerged from what they view as stolen local knowledge. Researchers should ensure that their research fully involves the indigenous people not just as subjects but also to help them to understand better and perpetuate their own traditional knowledge.

All this is about how researchers should go about their work. But what should be the aim of the work? The first step must be an inventory and description of local knowledge of biodiversity and sustainable use of its components. This is unlikely to be simple, because an observer may not understand local knowledge just by watching people. They will need to comprehend the culture so as to identify correctly those (often women) who hold the knowledge, discuss their concepts with them and translate their responses into scientifically useful terms. Subsequently the scientist must set about validating the local knowledge; again, this is not likely to be easy.

To end this contribution with a statement of research needs, I would suggest the following:

- Understand the status and trends of local knowledge in Europe (is it threatened?);
- Understand the extent to which European indigenous peoples or local communities restrict access to local knowledge or treat it as a common good.

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**Local public values of biodiversity**- Felix Rauschmayer, UFZ.

KEYWORDS: local arguments, local responsibility, role of science

SUMMARY: There is a tension between abstract philosophical arguments and local values determining conservation and management of biodiversity

The long-going philosophical debate on intrinsic values of nature vs. instrumental values or, termed differently: bio-/ecocentrism vs. anthropocentrism is an important debate, and I am convinced that it would make debates clearer if everyone dealing with conservation would have some insight in this debate. But in how far does this theoretical debate help us in practice? Such a question often is introduced by advocates of the instrumental point of view, claiming thereafter that what matters most to humans, i.e. to decision makers on biodiversity, are instrumental values.

I do not take this last point for granted, but the importance of instrumental values is not deniable. Any decision process, if it wants to consider the values human have, must be open to different kinds of values, intrinsic as well as instrumental (to take the two prominent categories in this debate), and the primary focus to identify them is on local grounds. Conservation can only work on the level of local communities that have the possibility to take up their responsibility for conservation.

In order to facilitate such responsible decision making, scientists have several tasks: (1) understand the local arguments (which is more than just knowledge, but is combining knowledge and values), (2) enrich the debate with their scientific knowledge (biological as well as economic, social, philosophical, etc.), (3) propose structures that help finding a decision (these can be participatory approaches, decision support with an open value basis, such as non-utilitarian multi-criteria decision aid), and finally (4) help implementing these decisions.

Research should give the kick-off, so that finally these steps could also be done by some kind of moderator, manager etc., or, ideally, by the local community itself. Research also needs to be done in order to create social institutions (or not abolish them for example via further privatisation), which make responsibility of local communities for conservation feasible.

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**The role of indigenous knowledge in biodiversity conservation**- Sandra Bell, Durham University.

KEYWORDS: Perception of nature, indigenous knowledge, participation, decision-making.

SUMMARY: The author discusses the various meanings of nature for human beings, the influence of culture in determining those values and the role of indigenous knowledge (IK) in the resolution of conflicts that arise around natural resources.

Contributions in the first session wandered into the territory of the meanings that nature holds for human beings. This seems to suggest that without a more refined understanding of those meanings we cannot expect to move beyond the old conservationist model of preserving nature in reserves. John Hucheson points out that reserves are not the solution.

We must realise that Wilson's ideas, raised by Allan Watt, are two-edged. In the book Wilson edited with Kellert, The Biophillia Hypothesis, there are explorations of how human beings can also react with deep-seated aversion to certain species, as anyone who has tried to campaign for people to care more about reptiles will avow.

Peoples' ideas, knowledge and feelings about nature are mediated directly through experience and also indirectly through social interaction. In such ways the meanings generated around nature are formulated in cultural values and representations. These may be altered by historical circumstance, are susceptible to political manipulation and often tied to resource management and distribution. Conflicts tend to arise around natural resources and these conflicts can be between opposing groups of people or between humans and other species.

Anthropologists, archaeologists and historians have demonstrated the variety of ways in which different human societies at different eras have perceived and related to nature. The scientific model that has come to dominate as a basis for decision making within nation states is counted as one model among many that survive, evolve and overlap in the modern world. Those who are not familiar with the scientific paradigm, or who also participate in different forms of knowledge and ideas about nature, may resist or be confused by the assumptions and regulations that arise from it.

Over the past few years there has been a move to attempt to resolve some of the problems inherent in this situation by recognising the importance of what is often referred to as indigenous knowledge - IK. (There is in fact a dispute about terminology that does not need to detain us here). A key issue in this work is the facilitation of meaningful communication and a realisation that more effective participation in solving problems can only be achieved with awareness of socio-cultural barriers in both directions. It is often the case that individual scientists demonstrate a keen appreciation of IK, but it remains unacknowledged at the institutional level.

Awareness of these issues is however only the beginning. While acknowledgment of the significance of IK is essential for successful conservation initiatives, it is not an easy option. Prof Paul Sillitoe, who has published extensively on the topic, points to the specificity of IK, which makes it difficult to work with against the generalisations that inform national or international policy or practice. IK is not static and is subject to continuous negotiation by stakeholders. IK is diffuse and conveyed piecemeal in everyday life; there is often no absolute consensus among local people equivalent to textbook knowledge. Finally, in depth research into IK requires a long-term commitment and can be expensive, although it depends more on a sufficiency of field workers than expensive equipment.

Despite these difficulties it is important that more IK research be carried out alongside action research that seeks to combine IK with enabling local people to set the research agenda and to participate in its unfolding. Both scientists and social scientists should be involved in order to integrate IK into an inter-disciplinary framework. The ethnographic record shows that people are frequently quite flexible and capable of moving between different paradigms according to circumstances, or even explaining one paradigm in terms of another. I show students a film where an agricultural extension officer from the Trobiand Islands describes Trobiand garden magic as "like western fertiliser". This is clearly more obvious to a Trobiand Islander, but it takes only a little empathy to enter the circle of understanding.

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**Biodiversity conservation through improved communication and benefit sharing schemes**- Michalis Skourtos, University of the Aegean.

KEYWORDS: Sustainability, biodiversity loss, communication, local knowledge, property rights

SUMMARY: Once the dichotomy of fact versus values is abandoned and proper communication is established between decision-makers and scientists, science and local knowledge will be more encouraged to benefit each other. Research should be focused on more 'subtle' and inclusive property rights regimes for biotic resources. Benefit-sharing schemes could be achieved by looking at negotiation breakdown through self-serving biases in fairness judgments.

It is hard to imagine human prosperity not dependent on the diversity of life. Wisely used, biotic resources guarantee the effective functioning of ecosystems that in turn supports past, present and future societies with a valuable range of key services. Nevertheless, this very prerequisite of sustainable living is currently under threat. The present e-conference underlines the role that science can play in reversing this trend. It is my contention that science will benefit in this respect if both scientists and decision-makers abandon the long established dichotomy of facts versus values when interfering with each other (House and Howe 1999). Only then can a true flow of information between evaluative discourse and scientific discourse take place (Norton 1998).

On a first level, the science of biodiversity can benefit from local knowledge in order to:

a) Support the choice of policy relevant spatial and time scales
b) Rank alternative working hypotheses
c) Achieve the appropriate level of abstraction and generalization

Science can also contribute to local knowledge by:

a) Informing the public on the technical conservation options available.
b) Set the lower and upper bounds for sustainable use of biotic resources.

From a policy point of view, the appropriation of (estimated) biodiversity values is equally important than their estimation. On the institutional level, a central focus of research should be therefore directed towards more 'subtle' and inclusive property rights regimes for biotic resources. This includes the need to realize investment opportunities, but goes beyond it by including questions of national sovereignty, natural heritage and global existence values. The corresponding 'property rights' regimes should be seen as a bundle of different use and access rights. How exactly scientific insights can help policy analysts in this respect remains to be investigated.

The ensuing issue of sharing the benefits of the sustainable use of biotic resources fairly reflects the issues of economic and cultural diversification of countries 'demanding' and 'providing' biodiversity. Normative principles of a fair benefit-sharing scheme are hardly agreed upon in multilateral environmental agreements. A possible way, I would especially recommend, is to look at negotiation breakdown through self-serving biases in fairness judgments.

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**RE: Improved communication and benefit sharing schemes**- Heidi Wittmer, UFZ.

KEYWORDS: Communication, governance, property rights.

SUMMARY: The author agrees with the importance of communication in biodiversity conservation, and identifies the different stakes involved. She goes on to discuss biodiversity governance and the need to relate the multiple actors and the multiple levels to each other.

In my view Michalis Skourtos has highlighted several key issues for biodiversity conservation. Communication is crucial for a better understanding of issues and stakes. In my view one fundamental challenge here is that local communities, whether indigeneous or "just" local, are not homogeneous and not the only groups with stakes involved. So we have different often competing groups and interests at the local level as well as stakeholders from other levels (including the global level and future generations). A second challenge arises from the the fact that the stakes and perspectives differ as well. So whereas in the context of biodiversity science the issue consists of understanding and conserving how biodiversity

functions, etc., other stakeholders are interested in using certain biological resources, combating threats to their livelihood production (e.g. in the form of animals feeding on their crops), or maintaining sacred cultural elements, or they might be only interested in using the land for other purposes whether consciously or not (construction, pollution deposition). What is at stake for the different groups has some overlap but differs considerably. Obviously the different interests involved are not operating on a "level playing field" some are organized, some have political influence others have other means of influence.

This is where the concept of property rights, especially conceived of as a bundle of rights, as Michalis Skourtos suggests, can contribute to understanding the different interests and stakes. Property rights are conceived of as a right an individual or group has to use, manage, reap the benefit from, sell or pass on certain resources. It becomes a right through the fact that society acknowledges and protects this right. This is the result of policy on the one hand and acknowledgement of the actors involved on the other. This is were I would like to introduce the term of biodiversity governance.

What is interesting is that for some aspects of biodiversity property rights are established whereas for others they are not. What multilateral agreements such as the CBD contributes is a framework within which the distribution of these property rights can be negotiated internationally. It is, however, only a framework. What social science research can contribute is to analyse the ongoing negotiation within this framework and understand how property rights are being assigned and redistributed in this context. Ulrich Brand and Christoph Görtz analyse the negotiation within the CBD on intellectual property rights and the unequal distribution between the industries involved and other interests at the international level. What this implies for the negotiation processes at national or sub-national levels is a second debate. Especially important with regard to EPBRS is the role science or more precisely arguments developed within science plays in these negotiation processes. Regina Birner and I have analysed how in the struggle on the community forest law in Thailand, which was essentially a renegotiation of property rights to forests, arguments from different scientific debates (hydrology, biology and social science) have been used by the competing groups in society. So communication issues and benefit sharing in biodiversity conservation go much further than the interaction between scientists and local groups. Research on these questions in the context of biodiversity is so far at best anecdotal. To understand governance implies relating the multiple actors and the multiple levels to each other. I would be very interested in learning more about what Michalis Skourtis suggests: "to look at negotiation breakdown through self-serving biases in fairness judgements" as a possible way to establish normative principles for a fair benefit-sharing.

In my view what is central for EPBRS in this context is to intensify the ongoing interaction between the different disciplines in order to better understand the interrelations between biodiversity research and biodiversity governance.

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**Biodiversity assessment and human adaptation-** Anne Larigauderie, DIVERSITAS.

KEYWORDS: Biodiversity assessment, multidisciplinary integration, human adaptation

SUMMARY: Research priorities include the assessment of current biodiversity including links with ecosystem functioning and structure and ecosystem services. Another consideration is the link between environmental changes and human responses or adaptation.

Knowing what main biological resources we need is a very difficult task since about 90 percent of the species on Earth are unknown. Therefore assessing current biodiversity, and documenting the functional role in the ecosystem of newly discovered organisms remains a priority.

Our efforts must continue to document the link between biological diversity and ecosystem structure and functioning, if we are to understand the impact of biodiversity changes (loss, invasive species, etc). This work must now be expanded to larger spatial and temporal scales, and include additional trophic levels.

A new dimension to the work described above must also be developed. To understand the risks to humans associated with biodiversity changes, we must become able to make a link between biodiversity loss and ecosystem structure and functioning on one hand and ecosystem services, on the other hand (eg predation, productivity, carbon sequestration). The notion of ecosystem services represents a key way to synthesize our knowledge to assess biodiversity. Determining how ecosystem services relate to changes in species composition and ecosystem processes requires integrating population and community ecology, ecosystem dynamics and economics.

One last key consideration is the consideration of human adaptation to changes in environmental services. As an integral part of the biosphere, humans trigger biodiversity losses and affect the quantity and quality of services provided by the environment. In the face of such changes, humans adapt to their new conditions by modifying their behaviour. For example, the loss of a local source of drinking water may be replaced by importing bottled water from another location. A reduction in a fish stock might cause the fishing sector to adopt more advanced fishing technologies, to start fishing another more abundant or less valued species, or to develop harvest-sharing rules that promote conservation of the stock. After the local loss of indigenous bee species, fruit growers may choose to leave the industry, purchase bees or pollinate flowers by hand.

Changes in environmental services trigger human responses. Describing the process of human adaptation to changes in environmental services, assessing its costs (and sometimes its benefits), efficiency and equity losses is key to an integrated understanding of the risks associated with biodiversity changes and loss are is being addressed in the context of the Core Project 2 of DIVERSITAS.

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**Biodiversity Values and Uses**- Gina Green, Oxford Forestry Institute.

KEYWORDS: Biodiversity, eco-agriculture, Equator Initiative, report card.

SUMMARY: With the projected increase in human population and the subsequent consequences on biodiversity, the author argues that there is a need for sustainable and adequate food production complimenting biodiversity protection and management, such as the Equator Initiative.

By the middle of this century human population is projected to grow from 6 to 9 billion, mostly in the low-income tropics and subtropics of the developing world. More than 1.1 billion people live within the 25 global biodiversity hotspots that ecologists describe as the most threatened species-rich regions on earth (Myers et al 2000). Of the 17,000 major protected areas declared and dedicated to biodiversity conservation, 45% have at least 35% of their land used for agriculture. E.O. Wilson in his book, The Future of Life, writes about the need for humans to change their ways otherwise half of all species could disappear by the end of this century. Scherr and McNeely in their recent book “Eco-agriculture” provide examples of transforming agriculture from a major threat to biodiversity to a valued contributor. They specifically show the use of conservation measures and new agricultural techniques that have improved rural livelihoods by increasing incomes and household nutrition while providing collateral bio-diversity benefits such as an increase of water supply, reduction of soil erosion and sustainable production of fuel wood (McNeely and Scherr, 2003). However, they also point out the lack of working models and the need to scientifically document large-scale sustainable agricultural production that compliments biodiversity protection.

A noteworthy, global initiative that is investing in human communities based in the tropics is called the Equator Initiative. This initiative recognizes successful community efforts in the developing world that are creatively and effectively using their biological resources in sustainable ways to improve their livelihoods. These communities have developed technologies and approaches to use biodiversity for food, medicine and/or income generation. The Equator Initiative is just one initiative among others that is attempting to promote and publicize community-based activities that demonstrate the inter-relationships among poverty alleviation, sustainable agriculture and bio-protection.

One major missing component at the political and financial decision-maker's level is understanding the linkages between policy and on the ground action. There is no integrated framework or "report card" which captures and holds accountable the roles of aid, finance, business and civil society sectors which are promoting or contradicting the policies and conventions set up to protect biodiversity while promoting sustainable agriculture production. There is a need for a monitoring process that bridges agriculture and biodiversity. Currently, a multitude of conventions and treaties exist at the international, regional, and national levels endorsing appropriate policy and strategy to reduce hunger. While they provide environmental stewardship, there is no overall reporting mechanism linking policy to action. The global community has no report card conveying to civil society the positive and/or negative impact regarding these efforts.

In conclusion there is a need at the global level to for a consensus that sustainable and adequate food production compliments biodiversity protection and management. Lastly, only an integrated effort among the various sectors of government, business, agriculture and environment will achieve the high level agreements such as the Millennium Development goals for food security, poverty reduction and bio-protection.

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**Approaches to the Estimation of the Values of Biodiversity: Non-market and Market Approaches**- Timo Goeschl (University of Cambridge), Andreas Kontoleon and Timothy Swanson (University College London).

KEYWORDS: biodiversity values, non-anthropogenic valuation, stated preference, revealed preference, production function, search theoretic approach.

SUMMARY: Several approaches have been developed to address the problem of valuing biodiversity. Most are based on the marketed goods and services derived from biodiversity (e.g. information, insurance) and the values that society places on these sorts of goods and services. Some others have recognised that many of biodiversity's unique values flow outside of the market, and attempt to estimate them without reference to marketed goods and services. Others have gone so far as to attempt to value biodiversity without reference to human society, a non-anthropocentric approach. In this piece we describe each of these approaches to the valuation of biodiversity in turn.

1. Non-anthropocentric Valuation of Biodiversity: Diversity Metrics

One approach to biodiversity valuation has attempted to value diversity as an end in itself. The Weitzman (1992) model is the foremost example of this literature (see also Weitzman 1993, Solow and Polasky 1992). In all of these papers, the assumption is that biodiversity has an important role to play, and that it has this value irrespective of the existence of a society or market that values it.

Refining the pioneering work by Solow et al. (1993), Weitzman (1992, 1993) offers the most sophisticated approach to translating biologists' analysis of taxonomy into an optimisation framework. Here, diversity is rigorously defined as a quantitative variable elated to taxonomic concepts of relatedness. Weitzman assumes that there is perfect information about the genetic make-up of each species, and that we are then able to rank the "relatedness" of a given set of species.

In short, the Weitzman approach takes genetic similarity as the common metric for valuing biodiversity. To the extent that one set of genetic resources has more dissimilarity than another set, this feature alone is enough to give it a greater value. The construct of a measure of value absent any sort of social or utilitarian justification is the essence of this approach. It is based in a belief system that provides that in the case of biodiversity it is possible that values might exist irrespective of the existence of human society.

2. Preference Based Methods: Non-market Valuation Techniques

If it is concluded that human preferences are the appropriate metric for assessing the value of biodiversity, substantial problems remain with the determination of the method for assessing that value. Many if not most of biodiversity's goods and services do not flow through any market or other social institution. Most of the many millions of species that exist

on earth do not have a known or noticeable impact on human society, but many individuals would nonetheless recognise the rights of these species to exist. Most approaches to valuation attempt to register these human preferences for other species' existence, with or without the use of markets. Non-Market valuation techniques are classified into stated and revealed preference techniques.

Stated Preference techniques (including contingent valuation, choice experiments, and contingent ranking) are used in situations where non-market based values need to be estimated and/or when no surrogate market exists from which environmental (use) value can be deduced. These techniques use questionnaires to develop a hypothetical market through which they elicit values (both use and non-use) for the environmental good under investigation. Stated preference techniques do not suffer from the same technical limitations as revealed preference based approaches (see below) and can also be applied to non-use values. Yet, the hypothetical nature of the market constructed has raised numerous questions regarding the validity of the estimates (See Bateman et al., 2003 for a review).

Table 1 gives an example of a set of stated preference studies that have been used to estimate the willingness to pay (WTP) for a range of different endangered species.

**Table 1. WTP for Endangered Species.**

| **Species** | **WTP Amount (US$)** | **Authors** |
|---|---|---|
| Bald eagle | 19.28-28.25 | Stevens *et al*. (91), donation |
| Bald eagle | 10.62-75.31 | Boyle *et al*. (87) |
| Striped shiner | 1-5 | Boyle *et al*. (87) |
| Northern spotted owl | 34.8 | Rubin *et al*. (1991), p.h. |
| Whooping crane | 31 | Loomis *et al*. (93), p.h. |
| Wild turkey | 7.11-11.86 | Stevens *et al*. (91), donation |
| Coyote | 3.40-5.35 | Stevens *et al*. (91), donation |
| Bottlenose dolphin | 7.0 | Pearce (96), 90US$ |
| Sea otter | 25 | Loomis *et al*. (93), p.h. |
| Monk seal | 62-103 | Samples *et al*. (90),1 |
| Blue whale | 40 | Loomis *et al*. (93), p.h. |
| Humpback whale | 125-142 | Samples *et al*. (90),1 |
| Sea turtles | 13 | Loomis *et al*. (93), p.h. |
| Rhinos | 5-12.67 | Swanson *et al* (98) |
| Pandas | 14-16 | Kontoleon and Swanson (2000) |

*Source:* Kontoleon 2003

*Notes: i) values not adjusted for inflation*

*ii) p.h.: per household; 1: once only payment; p.p.: per person; p.a.: per annum*

3. Market based Estimation: Surrogate Markets Approach

Revealed preference valuation techniques (including travel costs, hedonic pricing and wage differential approaches) rely on information from individual consumption/ purchasing behaviour occurring in markets related to the environmental resource in question (surrogate markets). The price differential of the good (purchased in the surrogate market), once all other variables that affect choice apart from environmental quality have been controlled for, will reflect the purchaser's valuation of that particular level of environmental quality. These methods have the appeal of relying on actual/observed behaviour but their fundamental drawbacks are the inability to estimate non-use values and the dependence of the estimated values on the assumptions made on the relationship between the environmental good and the surrogate market good.

Using the "travel cost approach", for example, it has been possible to estimate the value of various forms of parks and protected areas. The idea is that the costs of travel act as surrogates for the non-marketed good, i.e. the biodiversity within the park or protected area that is the reason for the travel. This assumption enables the approximation of a demand curve, and the estimation of values placed on the non-marketed values.

Table 2 summarizes the results from a set of travel cost studies that have estimated visitor consumer surplus for various national parks.

Table 2. Summary of Travel Cost Studies

| Study Area | Consumers' Surplus Estimate | Author |
|---|---|---|
| Eurobodalla National Park | $4.80 to $19 per visit ($1996) | Lockwood and Lindberg (1996) |
| South East Forests | $8.90 per visitor ($1992) | RAC (1992) |
| Gibraltar Range National Park1 | $19 per visit ($1995) | Bennett (1995) |
| Dorrigo National Park2 | $34 per visit ($1995) | Bennett (1995) |
| Minnamurra Rainforest Centre, Budderoo National Park | $28 to $48 per visit ($1996) | Gillespie (1997) |

*Source: Gillespie (1998)*

*Notes:*

*1. Average stay is almost 2 days*

*2. Average stay is half a day.*

4. Market Based Estimation: Production Function Approach

An approach related to the surrogate market approach is the production function approach. This method derives from the assumption that the non-marketed good or service is an important input into the production of a marketed good or service, such as the role of clean air as an input into the production of human health.

Evenson (1995) has used this approach to estimate the contribution of genetic resources to plant breeding. This is done by specifying an "R&D production function", and then estimating the extent to which its various component parts have contributed to the past production of new information. An R&D production function in the context of plant breeding, for example, would have to consist of at least: i) the scientific input (human capital); ii) the technological input (physical capital); iii) the genetic resource input (natural capital). The theory of a production function states that increases in these various inputs would result in increases in the desired output: new modern plant varieties. (Evenson and Gollin 1991)

(Evenson 1995) applies this theoretical framework to conduct an empirical study which attempts to estimate the relative contribution of genetic resources in the R&D process in plant breeding. Here the R&D production function of new plant varieties N is specified as: N= f (LKG) where L: level of input from human capital (scientists) , K: level of input from physical capital (technology, machinery) and G: level of input from genetic capital (biological diversity).

The empirical study is based upon the record of plant breeding at the International Rice Research Institute since 1960, and estimates the extent to which new varieties of rice were attributable to the various forms of investments. This study estimated that approximately 35% of the production of modern new rice varieties has been attributable to the genetic resource input into the R&D function. This implies that the inputs supplied by plant breeders in rice breeding (human and technological) generated no more than 65% of the useful information within modern plant varieties. The imputed present value of a single landrace accession according to this study was $86-272 million. The imputed present value of one thousand accessions with no known history of use was $100-350 million. Given that the initial stock of rice germplasm (in 1960) was 20,000 accessions, the added stock of germplasm since that time (about three times as many accessions) have been estimated to be responsible for fully 20% of the green revolution in rice production (Evenson 1995). In the context of rice production, diverse germplasm contributes 35% of the "total input" required for the production of a new plant variety.

5. Market based estimation: Search-theoretic Approach

In an influential article on the valuation of genetic resources, Simpson et al. (1996) develop a search-theoretic perspective on the problem that is inspired by (Brown and Goldstein 1984). They ground the value of biodiversity in the activity of "biodiversity prospecting" by an R&D intensive industry and deduce the marginal willingness to pay for an additional sample to be prospected when screening of samples is costly. The aim of their work is to quantify the willingness to invest of private firms in the conservation of biodiversity when the value of each sample is the outcome of a Bernoulli trial (the screen). In other words, they evaluate genetic resources from the vantage point of expected private profits from research.

The typical model features a fixed probability p of identifying a valuable trait in a sample where valuable traits give rise to a product with fixed revenue R through a process of further R&D. The cost of screening a sample is fixed at level c. The expected value of a search over n samples can then be expressed as V(n) which is V(n) = pR-c+ (1-p)(pR-c) + (1-p)2 (pR-c) + ….. The marginal value of the nth sample is then v(n) = (pR-c)(1-p)n.

The empirical problem with the formulation in this equation is that the probability of a 'hit', p, is the most important parameter for estimating v(n), but that data on p is notoriously difficult to obtain. Simpson et al. solve this dilemma by evaluating the expected value of the marginal species under the most optimistic conditions. One interesting finding is that the function mapping the probability of success in any single trial to the value of the marginal species is single-peaked and strongly skewed to the right. This means that once the probability of a successful trial is such that the expected marginal value of a trial exceeds the cost of the trial, the value will rise very rapidly to its maximum value and then decrease again rapidly. This observation is crucial as it shows several points: Sampling costs are an essential determinant of the marginal value, and studies that do not take these costs into account are bound to overestimate the marginal value significantly. Secondly, the fact that the marginal value of the species is not a monotonously increasing function of the probability of success brings an issue to the fore that had previously been overlooked by many researchers, namely the presence of substitutability between species.

If substitutability is very scarce, i.e. the probability of success is very low, then the marginal value is depressed since the expected revenue from the marginal trial is too low to warrant a high volume of trials. If substitutability is not scarce, then the expected revenue from the marginal trial is too low to warrant a high volume since it is very likely that a success has occurred already. In other words, if there is a high level of redundancy within the stock of samples, a significant proportion of the samples can be discarded prior to screening with little loss of expected revenue since it is very likely that a success will be found within the remaining portion.

Based on a number of reasonable assumptions regarding the market value of a product and other parameters, Simpson et al. derive an upper bound for the willingness to pay for the marginal sample and translate this into an per-area WTP for conservation using the common MacArthur-Wilson approach of relating habitat size to the extant stock of biodiversity. Based on this computations, the maximal willingness to pay for a hectare of biodiverse lands in Western Ecuador, one of the „biodiversity hot spots", is US$20,63. The rainforests of the Amazon elicit only US$2,59 per hectare. This implies that most areas with even extraordinary biodiversity do not justify significant payments from the pharmaceutical industry for their preservation. The conclusion of Simpson et al. Is that there is little reason to expect that the industrial use of genetic resources will result in their preservation by private investors.

The problems with this approach to valuation of biodiversity as an R&D input are well-studied. First, if there is prior information about which areas are more likely to produce information on which problems, the values of marginal biodiversity are altered significantly. (Rausser and Small 2000) Secondly, if there is a belief that problems will continue to reemerge on account of selection and resistance, then the social value of biodiversity (as opposed to the private patent-based values) are much greater. (Goeschl and Swanson 2002).

Conclusion

Numerous sorts of approaches have been taken to estimating the value of biodiversity. The problem is complicated by the fact that the value of biodiversity is both a fundamental philosophical question concerning the relationship between human society and the biological world, and a difficult methodological question concerning the nature of the values that are to be estimated.

The problem is further complicated by the fact that, in the most fundamental sense, the value of biodiversity is boundless. One interesting paper has conceptualised the value of biodiversity as the value of catastrophe-avoidance. (Weitzman 2000). And another researcher has stated the belief that any numerical value placed on the ecosystem services delivered by biodiversity "is a serious underestimate of infinity". (Toman 2000) Without some amount of biodiversity it is generally accepted that the world as we know it could not function, and this fundamental notion undermines any attempt to estimate partial values of biodiversity.

Nevertheless, it remains a useful exercise to apply scientific methodologies to the ascertainment of various parts of the value of biodiversity. The anthropocentric values of biodiversity range from clear use values, such as insurance and information, to very abstract non-use values, such as the existence values of endangered species. Careful construction of valuation methodologies is required to capture any of these values. In no case is there a direct market-based method for deriving the value of any of biodiversity's goods and services. These estimates must be inferred from the application of methodologies based on various surrogate goods and markets, and even from stated preference techniques.

This survey has demonstrated the range of methods available for use in valuing these various parts of biodiversity's goods and services. Although these studies can only estimate small parts of the total value of biodiversity's goods and services, each one demonstrates that there is emerging a set of scientific methods capable of careful estimation of some of these values. Although together they must always represent "a serious underestimate of infinity", they do provide some guidance to policy making for biodiversity conservation. (Kontoleon, Macrory and Swanson, 2002).

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**RE: Approaches to the Estimation of the values of biodiversity**- Felix Rauschmayer, UFZ.

KEYWORDS: Valuation of biodiversity, social values, ecological values, economic values.

SUMMARY: There are further methods available for valuing biodiversity than those described by Timo Goeschl, Andreas Kontoleon and Timothy Swanson in their contribution of 11th April. The difficulty is not finding the optimal method for all cases (there is no such thing), but (1) to identify the whole range of values associated with biodiversity, (2) to capture these values and (3) to aggregate them. Approaches based on monetarisation are one type of method that can be used in the first and second step, but must be complemented by many other approaches. Multi-criteria analysis is a method that can be used for the third step, and the whole process (1) to (3) can be called (social) multicriteria decision aid.

Goeschl et al. give the impression that they described all available methods for biodiversity valuation. They picked one non-monetary evaluation method (developed by an economist) which is valuing "diversity" as an intrinsic value, and added 4 other methods which are all based on markets (even though one is currently called "non-market valuation techniques"). I will not insist on the strong assumptions that any of these methods implies, but rather insist on the evidence that neither the valuation of diversity as an intrinsic value nor the capturing of monetary values is able to cover all values that are linked to biodiversity (there is an extensive literature on this issue in the journals Environmental Ethics, Ecological Economics, and Environmental Values, see for one possible structure of values: Krebs 1999).

There is nothing wrong with capturing monetary values for some parts of biodiversity, but it is more important to analyse which values are captured, and which aren't. And then: how can we capture these other values? and how can we aggregate them?

For the first step, an interdisciplinary (and mostly transdisciplinary, i.e. including the concerned public interactively) scoping process is necessary. Ecological, sociological and

economic methods can be judged appropriate to capture all values in a second step. But before capturing, it must be clear how these values are aggregated in order to be of use to responsible decision-makers. Only if the aggregation method (it can be verbal, mathematical, or a combination of both) is known, can the choice of methods make sense. Up to now, environmental economists focused intensively on the further elaboration and refinement of methods without placing them in a wider context of public decision-making within societies.

A range of methods used more and more for the integration of the evaluation results of different policy options according to different criteria (or values, as I called them above), is multicriteria analysis (cf. http://www.dtlr.gov.uk/about/multicriteria/index.htm, a good text book is Bouyssou et al. 2000). In many cases, the efficiency and the normative quality of the results are improved by embedding such a process comprising of three steps: identification of the values, evaluation, and aggregation, in a participatory process (Renn 1993, Tacconi 2000, Munda 2003, Wittmer et al. 2003).

Session 3. How can we integrate our knowledge into new technologies, innovative plans for local development and biodiversity conservation?

**Repent! The end is nigh!**- Martin Sharman, European Commssion
KEYWORDS: Sustainability, biodiversity loss as an indicator.
SUMMARY: The Meadows, Meadows and Randers (MMR) decline and fall is looming on the horizon. If we achieve the Goteborg target we may save our civilization.

In previous contributions I have stressed the normative values of biodiversity. I would now like to change tack and look at its ultimate utilitarian value - the role of biodiversity in the survival of our species, or at least of our planetary civilization.

In their book "Beyond The Limits", Donella and Dennis Meadows and Jørgen Randers claim that the current rate of human use of many essential resources cannot be sustained. They foresee in the next decades a catastrophic collapse of per capita food output, energy use, and industrial production unless we quickly take action to reduce our consumption of material and energy and to stabilise human population size. By "quickly" they mean "with utmost urgency".

Rates of biodiversity loss are an excellent index of sustainability. If we are losing biodiversity, our demands on the natural system are unsustainable. It is as simple as that. Conversely, if in the next 6 or 7 years ("2010" sounds futuristic) we can reduce global biodiversity loss - and halt its loss in Europe - we may avoid the "MMR catastrophe".

And this means that the question of our final week, "how can we integrate our knowledge into new technologies, innovative plans for local development and biodiversity conservation?" may be the vital question for the survival of our civilization to the end of this century.

We know that to stop biodiversity loss we must address the root causes of loss; we must change many human values, attitudes and behaviours that tend to reduce biodiversity and hence are not sustainable at present population levels. We often talk of poverty as a root cause, but growth in a limited system is probably more dangerous. The "knowledge" that this week's question refers to is not just scientific knowledge about biodiversity. Is it possible to use the collective knowledge of our world civilization to cause our society, our politicians and our multi-national corporations to embrace sustainability, rather than growth, as a goal? If not, then what?

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**How will we know when the end is nigh?**- Allan Watt, CEH Banchory
KEYWORDS: Monitoring, integrated research, human values and attitudes, drivers and pressures of biodiversity.
SUMMARY: The only way that we will achieve the Gotenborg target to halt the loss of biodiversity by 2010 is to create a truly integrated research framework for biodiversity in Europe, linked to the core programme of biodiversity monitoring recommended by a previous e-conference.

In this session, Andreas Troumbis asks us to consider the question “How can we integrate our knowledge into new technologies, innovative plans for local development and biodiversity conservation?” Martin Sharman considers that this “may be the vital question for the survival of our civilization to the end of this century” and argues that rates of biodiversity loss are not only important in themselves but as an index of the ability of the human species to survive on this planet.

But where does research – the realm of EPBRS – come into this?

The first thing that I thought of was the first thing that I always think of when the Goteborg target is mentioned – how will we measure progress towards this target (to halt the loss of biodiversity by 2010)? There is probably no need to raise this topic in this e-conference; it was discussed at length in the e-conference preceding the EPBRS meeting in Denmark last year. But perhaps it is worth mentioning that that e-conference concluded that

there is a need for a core programme of monitoring biodiversity in Europe that should comprise two elements: an extensive network of monitoring sites using simple protocols and a series of intensively monitored sites primarily intended to test the methods being used in the extensive network. The subsequent EPBRS agreement endorsed the need for a core programme of monitoring biodiversity as the first of its priorities.

This e-conference is about more than monitoring. Martin Sharman writes that "…to stop biodiversity loss we must address the root causes of loss; we must change many human values, attitudes and behaviours that tend to reduce biodiversity…" To do this effectively we first need more knowledge, particularly on the root causes of loss (the drivers and pressures that determine biodiversity) and on human values, attitudes and behaviours.

But secondly, we need to acquire this knowledge in such a way as it is most meaningful and most readily applied to address the loss of biodiversity in Europe. This means a shift towards more integrated research. This integration should be done in several dimensions. We need much more collaboration, on the one hand, between researchers working on, for example, the socio-economic drivers that are the root causes of biodiversity loss and, on the other hand, between the researchers that seek to quantify the impact of the various pressures that affect biodiversity, such as climate change, alien invasive species and land use change. Largely as a result of European Union funding these topics are being addressed in a collaborative way. But we need more than collaboration; there needs to be integration between researchers working on different pressures in order to obtain and understanding of their integrated impact. And the work of these scientists needs to be integrated with that of researchers working on socio-economic drivers.

I could go on but I will mention only one more area. The reason I referred to a previous e-conference in such detail above is that I believe that research on the drivers and pressures of biodiversity should be integrated with the core monitoring programme to create much more than a network – a biodiversity monitoring and research observatory system.

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**RE: How will we know when the end is nigh?** - Sandra Bell, Durham University.

KEYWORDS: social scientists, ecologists, cooperation, workshop, interdisciplinary research.

SUMMARY: The author calls for mutidisciplinary workshops where social scientists and ecologists could understand each other's perspectives and goals better. She also suggests a pilot project where social and natural scientists devise and carry out a project with a special emphasis on their cooperation efforts. I believe that Allan Watt is right about the need for social scientists and ecologists to integrate their research - it is one thing to have mutlidisciplinary research and quite another to achieve interdisciplinary research. However, the ideal of integration cannot be achieved without clear and determined effort.

There is a crying need for mutlidisciplinary workshops, probably starting at a fairly basic level, where social and natural scientists get together and try really hard to understand one another's perspectives, methods, language and preoccupations. Talks or lectures are not enough. Social scientists may need to find themselves down in the mud doing some field ecology and ecologists may have to find themselves doing something like ethnographic fieldwork. That way we can find out what one another does, how it feels and what we want at the end of the day. The different disciplines will only reach the kind of co-operation that is required if their members set out a deliberate programme to create it.

I propose a pilot project that is founded on a valid piece of research, but which is actually a vehicle for the creation of this kind of co-operation. Here social and natural scientists would get together to devise and carry out a project. It would be understood that the primary aim of the project was to work on interdisciplinary understanding. To this end special workshops and other events would be dedicated. The project may or may not answer the academic questions it set out to answer, but the funders would understand that this outcome was of secondary importance. The project would also track down and investigate examples where interdisciplinarity had been achieved to varying degrees.

The participants would commit themselves to answering certain questions as in any research project, but blind alleys and methodological problems would be considered grist to the mill of self-reflexivity and interdisciplinarity. If some or all of the research questions did not get answered that would not matter providing that the participants provided an insightful and useful account of how their efforts at co-operation did or did not work.

Contributors to this conference appear convinced of the need for interdisciplinarity, but we have to devise and implement experiments and other means if willingness is to transform into actuality.

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**RE: How will we know when the end is nigh?-** Christos Arvanitidis & Anastasios Eleftheriou (MARBENA moderators), Institue of Marine Biology of Crete.
KEYWORDS: Marine Biodiversity, EU policies.
SUMMARY: Marine scientists may feel that they cannot adequately address the question of how the loss of biodiversity can be halted by 2010, based on the present level of knowledge. However, radical changes in EU policy may have more powerful to solve this problem than knowledge alone.

During the last week the MARBENA e-Conference was running as a separate Conference, with one of the sessions entitled "the unknown". In the summary of the session (http://www.vliz.be/marbena/summaries.htm ) one can find listed a number of serious gaps in our knowledge on Mediterranean Marine Biodiversity, which is not the only example, ranging from gaps in biodiversity distribution at any spatial and temporal scale to relationships between biodiversity and ecosystem functioning and inefficiencies resulting from the absence of coupled classical and modern taxonomical tools. Consequently, the picture seems to be rather worse in the marine than in the terrestrial ecosystems.

There are, however, a number of features of Marine Biodiversity that differentiate it from Terrestrial Biodiversity and hinder our efforts to understand and consequently to conserve and evaluate the marine systems:

1. Diversity at higher taxonomic levels is much greater in the sea (fourteen "endemic" marine phyla, compared to one terrestrial).
2. A greater variety of species at a higher trophic level are commercially exploited in the sea.
3. The marine physical environment is totally different from the terrestrial physical environment.
4. Dispersal of species may occur over much broader ranges than on land.
5. The main primary producers are very small sized and often mobile in the sea.
6. The standing stock of grazers is higher than that of primary producers in the sea.
7. Ocean productivity is on average lower than land productivity.
8. High level carnivores often play key roles in structuring marine biodiversity.
9. Marine biodiversity is the most exposed to pollution.

Our understanding of marine biodiversity lags far behind that of terrestrial biodiversity. It has became a commonly shared idea in recent years that the patterns and processes (and the potential consequences), which have been proved to exist in the terrestrial systems cannot be accepted as valid for their marine counterparts without any further examination.

On the other hand, marine ecosystems may provide a variety of goods and services to humans. Changes in marine biodiversity not only affect the natural environment but also the associated social and economic systems (e.g. wild capture fisheries). In most cases, however, the utilization of these goods and services is poorly regulated or not managed at all. More recently, marine scientists have become aware of the need to manage marine ecosystems for the conservation of biodiversity and sustainability of ecosystems functioning.

Now, based on the above, marine scientists may have fewer chances to answer questions such as "how to achieve the Gotenborg target to halt the loss of biodiversity by 2010". The potential of an umbrella Project for biodiversity monitoring has been already proposed during the MARBENA Conference, but we do not think this would be enough. We

find also it difficult to answer the question posed by Andreas Troumbis: "How can we integrate our knowledge into new technologies, innovative plans for local development and biodiversity conservation?" from a marine biodiversity point of view.

We can deliver, however, a couple of policy changes, at least in the context of the European Union, of essential importance:

1. To replace our "primitive" way of burning oil for energy production by other technologically more advanced solutions (e.g. hydrogen reactors).
2. To replace our "aggressive" anthropocentric economic attitude by a "peaceful" environmentally benign economy.

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**Biodiversity, resources and development – a broad interpretation**- Angheluta Vadineanu, University of Bucharest.

KEYWORDS: Biodiversity, organization, natural capital, socio-economic complexes, conservation.

SUMMARY: Biodiversity is the foundation and a source of a wide range of natural resources and services as well as the interface with socio-economic systems within the socio-ecological complexes.

The concepts and methods dealing with the “environment” (physical, chemical, biological, including human dominated and created environment) have been changed and improved as the ecological theory has developed from the early stage, usually described as “biological ecology”, towards the current stage, which is more often and more appropriate defined as “systems ecology”. The identification and description of the natural, semi-natural and human-dominated and created environment has changed as well from a former conceptual model which defined the environment as an assemblage of factors: air, water, soil, biota and human settlements, to the most recent one, which considers that the environment has a “hierarchical spatio-temporal organization” (Odum 1993, Pahl-Wostl 1995, Vadineanu 2001, Holling et al. 2002).

The ecological systems, as organized units and components of the hierarchy, are described as self-organizing and self-maintaining systems or as life supporting systems. More recently, they have been described as non-linear dynamic systems with evolving productive and carrying capacity. Within the organizational hierarchy we find both natural and semi-natural ecological systems that are fully self maintained and self regulated as well as human-dominated ecological systems which depend in different degree on commercial auxiliary energy and material inflow for providing specific resources and/or services (e.g. agro-systems, forest plantations, intensive fish farms). These biophysical units have intrinsic values (non-use values) that develop in time as well as provide many use and non-use values related to the resources and services they produce at different rates according to the phase of development. In this respect we have to consider these types of biophysical units or ecological systems as the Natural Capital (NC) of a region or country as well as the potential ecological foundation for Socio-Economic Systems.

Within the hierarchy are also the human-made ecosystems (e.g. urban ecosystems, industrial complexes, transport network), which are fully dependent for maintenance and development on commercial energy and material inflow. It is not our intention to discuss in detail the many narrow or wide interpretations of the biodiversity concept, but we consider the importance of a clear option for a scientifically sound interpretation which covers the spatio-temporal organization and complexity of the living and non-living “environment” – i) diversity of ecological systems across space and time scale (which integrates biological and physical components of the environment); ii) species and taxonomic diversity; iii) genetic diversity within and among species; iv) human social organization, ethnic, linguistic and cultural diversity. The appropriateness of such option to the real world is expected to have a great impact on the design, development and implementation of policies and management plans triggered on worldwide recognized objectives dealing with conservation and sustainable

use of biodiversity or sustainable development/or "balancing the structure and metabolism of economic systems with the spatio-temporal dynamics of biodiversity".

According to the above statements, we use "biodiversity" as the broader meaning which covers on one hand the components of Natural Capital together with their taxonomic and genetic diversity and on the other hand, human social organization, ethnic, linguistic and cultural diversity. In other words, we can say that biodiversity consists in Natural Capital, Social and Cultural Capital and provides, on one side, the foundation which supports and feeds with resources and services the Socio-Economic Systems and, on the other side provides the interface between Natural Capital and the structure and metabolism of the "economic subsystem".

From this point of view it is obvious that each population and species has its own role for the maintenance and evolution of the higher level of biological (e.g. communities) and ecological systems as well as for their production and carrying capacity. Genetic diversity at the species level provides the adaptive potential and support for speciation. Species richness and genetic diversity provide adaptive potential and support for adaptive transformations and evolution of the ecological systems (natural, semi-natural and man-dominated). Social, cultural and human genetic diversity provides the adaptive potential for the evolution and development of Socio-Economic System. Only in these conditions can natural, man-dominated and man-created systems cope with surprise and uncertainty.

Conservation of "biological and ecological diversity" or "biodiversity" from this perspective does not appear as a peripheral issue (as was and unfortunately still is considered), but as the core issue for sustainable development (as an adaptive process across space and time which is taking place in socio-ecological complexes). Hence the conservation of biodiversity and its adaptive potential by balancing the spatial and exchange (mass, energy and information) relationships among natural capital and economic systems across space and time scales is a pre-condition for sustainability and finally for preventing loss of components of biodiversity at all levels (genetic, taxonomic, socio-cultural and ecological).

For holistic and adaptive management of the dynamics of socio-ecological complexes across space and time in order to achieve the goals of biodiversity conservation and sustainable development, we certainly need among other things a package of complementary methods and procedures for economic valuation of natural resources and services as well as to set up thresholds for spatial development and mass exchanges. However, it has to be recognized that the success of such work depends on reliable and complete data, information and knowledge from all levels of biodiversity. Currently we are facing many gaps and uncertainties concerning biodiversity data and knowledge. In addition the historical data and information is not properly structured or accessible. In these circumstances, long term research monitoring at all levels of biodiversity, coupled with the development of the "Support System for Holistic and Adaptive Management", based on well structured information systems and complementary tools for social and economic analysis, should be identified as key conditions for better governance.

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**Science for better governance**- Martin Sharman, European Commission

KEYWORDS: Role of science, uncertainty, precautionary principle.

SUMMARY: Policy makers need answers now, to questions that scientists are in (at least) two minds about. How should we approach this all-too-frequent dilemma?

Although it is not on the agenda, it seems to me that there is a key issue that this conference might want to address, which is how science contributes to governance, in day-to-day exchanges.

Policy-makers work on a different time scale from scientists. Policy-makers rarely have the luxury to look several years ahead for a possible solution to a problem - they very often need something that they can implement today (or tomorrow at the latest). Their decisions track phenomena (public pressure, drafts of documents, instructions from hierarchy, questions from parliament) in which change can be observed in days or weeks – and perhaps

even hours. This often means a "quick and dirty" partial solution, perhaps based only on very shaky scientific observations. Biodiversity scientists, on the other hand, typically work to the rhythm of multi-annual funding and project cycles, as they track hugely complex phenomena whose changes may sometimes be confirmed only after many years - and perhaps decades or more.

Let us suppose that the EPBRS manages to work out an excellent strategy for biodiversity research. Good though the programme may be, nobody can possibly predict all policy requirements. So even if some policies are based on solid science, some will always be based on unsatisfactory evidence. This is in effect what the precautionary principle states.

Policy makers are used to working in a world of ambiguity and incomplete information. They can easily accept that sometimes the advice they receive, even from the best scientists in the world, is not much better than an educated guess. It is much more difficult psychologically for scientists, who seek to reduce ambiguity as much as possible and who balance probabilities as a profession, to provide advice from a knowledge base that consists of more doubts than facts.

Here is my question to you, dear reader: how might scientists properly handle responses to requests for advice when scientific knowledge is lacking? Should they say "here is the best guess I have at the moment, here are my doubts about my guess, and here is the costed description and schedule of work needed to provide a better-substantiated reply in 10 years' time"? Can we work out a "best practice" manual to help scientists to deal with RASKLs? (A new acronym: of course it means "request for advice when scientific knowledge is lacking".)

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**RE: Science for better governance**- Josef Settele, UFZ.

Consistent with the content of Martin's question, just let me answer in a "quick and dirty" or let's rather say spontaneous way:

I think scientists, when asked for advice when scientific knowledge is lacking, should in fact say: "here is the best guess I have at the moment, here are my doubts about my guess" - I don't think it is of much use to talk about 10-years-time-research results from the individual scientist's perspective. But I think for a "best practice" manual one could consider consulting an ad-hoc-group of colleagues working in a related field and give a joint statement. Furthermore, for such a manual, frequently asked questions/advice can be collected as well as the scientists' answers as well (both of individuals and groups of scientists). Collating (and publishing??) such answers would also guarantee that the scientists have to clearly differentiate between their own opinion (educated guess) and "real" scientific evidence. This would avoid anonymity. I think in such cases this is important to prevent personal interests to dominate the advice. Such a procedure also avoids scientists asking for money for research that might be or have been conducted elsewhere. So if they make a costed description and schedule of work needed to provide a better-substantiated reply in 10 years' time, it has to be proven that such research really is needed!

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**RE: Science for better governance**- Rainer Muessner, CIMAR.

KEYWORDS: Role of science, uncertainty, "best practice" manual.

SUMMARY: Scientists have to face the dilemma to give answers to policy based on weak scientific ground, even if it touches their self-understanding as "scientist". A "best practice" manual will not solve the problem.

In reply to Martin's and Josef Settele's contributions about the topic I would like to add some comments.

Martin described very well the current practice in policy to make decisions (their decisions track phenomena (public pressure, drafts of documents, instructions from hierarchy, questions from parliament) in which change can be observed in days or weeks - and perhaps even hours.) I guess this behaviour is typical politician-like and is just a reaction to the general trends in society (or lets say "voter community"). Of course, if we speak of "good"

governance, this tendency should be counter-balanced by some long-term, strategic decision making, that opens visions in policy and maybe for biodiversity too. In this situation the time horizons of politicians can be even longer that those of scientists, that think in time-horizons like Frame programmes. Maybe long-term monitoring programmes can be compared to this kind of "good" governance.
In any case, scientists have very seldom the chance to influence policy. If it means to come to a "quick and dirty" partial solution, based on shaky scientific ground, we should do so. An answer like the one in Martin's contribution does not sound bad to me, except for the fact of having the new proposal to be funded on hand, to avoid personal interests to dominate the advice, like written in Josef's contribution. The alternative to give no answers and maybe leave the asking politician as informed as before (because the answer is not scientific secured) will bring us to the situation when politicians will not ask for advice next time and we will be "out of the game".

The second point Martin and Josef touched upon, was the "best practice" manual on how to advice policy. I really have my doubts about the usefulness of such a manual, because what to say or do, or how to promote knowledge and information for politicians is very situation-dependent, as well as the question of what actions will be based on the advice. To make clear what information is scientifically solid, what information is an educated guess and what are purely personal opinions should be a matter of course for a scientist. In any professional or official expertise in the field of biodiversity (i.e. EIA, SEA, a.s.o) we expect the expert to be clear about the origin and bases of information therefore we should expect the same while giving policy advice. "Best practice" manuals are valuable in a lot of situation and fields, but for "how to give policy advice" it seems to me to overshoot the mark.

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**Science and policy**- Katalin Torok, Hungarian Academy of Sciences
KEYWORDS: Role of scientists and officials.
SUMMARY: Decision making and science are exercised by different groups. To improve communication and understanding among them, both groups should involve young experts more in the process.

I agree with Rainer Muessner that a "best practice" manual for policy advice would be another document that would not be used. According to my experience first only in research and then working with government officials, the gap is great.... Scientists often make decisions arbitrarily, made in a "hectic" way, without sufficient scientific background. Officials think scientists cannot help them in their every day solutions as they are not "practical" enough and always speak about doubts. The problem is that both groups can develop a residing attitude that is passed to young experts. However, concerning longer and larger tasks as Natura 2000 site selection, forest reserves and biodiversity monitoring, a good collaboration can be achieved with minor problems. During such joint projects, tension has been reduced.

According to my opinion, biodiversity science and policy making have to rely on each other a lot, the "segment" is large, but not complete. Even such research has to be carried out that is not policy relevant at the moment (who knows what will be relevant in 3 years?), and officials can make certain decisions without asking scientists, as they themselves have a general understanding of biological processes. I see the future solution in propagation of the problem and the necessity of collaboration during conferences and in education. In Hungary, for example, several governmental programmes (biodiversity monitoring, ecological network) are included in university courses, and on the other hand, nature protection experts from national parks participate at ecological conferences. It should be made clear that there is a joint responsibility concerning biodiversity loss - the roles are a bit different, but both roles are necessary.

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**RE: Science for better governance**- Yiannis Matsinos, University of the Aegean.
KEYWORDS: Ecological risk assessment, model, invasion, management.

SUMMARY: The author suggests population models to help reduce uncertainty at the biotic level and help in decision-making. He also lists some fields that need more attention.

Martin Sharman's comments about treatment of uncertainty in decision-making, regarding biodiversity issues are really important. One way to deal with the uncertainty of potential outcomes of management actions for sensitive species is to develop population models, and through a probabilistic framework try to "encapsulate" uncertainty, at least at the biotic component. This approach termed Ecological Risk Assessment has been quite successful in many cases of hot conservation issues lacking all demographic information. By using all the available life history information about the species, and incorporating treatments for parameter uncertainty and environmental and demographic variation, it is possible to rank management alternatives according to which induces the lowest risk of decline or extinction. A similar quantitative approach is currently emerging in invasion ecology, where the probability of declining is substituted by the probability of spreading non-indigenous populations in natural systems.
It is however to be noted that models are of high complementary value to experimental approaches. My belief is that we need to make theoretical advances to the following topics/fields in an effort to make wiser decisions:
- Invasion as an ecological and economic process
- Risk assessment and quantitative appraisal of alternative management schemes
- Uncertainty management

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**The politics of biodiversity**- Alan Feest, Bristol University
KEYWORDS: Indicators, biodiversity assessment, standardised methods.
SUMMARY: The logic for a decision making process for making decisions relating to the valuing and preservation of biodiversity is discussed leading to a separate list of questions that should be addressed.

As usual, Martin Sharman has put his finger on the essential element of our discussions: how to turn biodiversity research into information for making sensible and appropriate decisions. I have a background in politics and business before becoming an academic so can see how difficult it is for scientists to provide what a decision maker needs. The clarity of information is not always available.

There are two approaches to this:

a) One is to deal with probability and make decisions through risk analysis and hierarchies of probability.

b) The second is to encourage scientists to start their research from the point of view that the results will have utility in decision making. I wish to address the latter of these options.

Much research is criticised by decision makers for not meeting their needs c.f. Martin's latest contribution. In biodiversity it is both more important and apparently even more difficult to make these decisions due to the overwhelming nature of the totality of biodiversity. The "quick and dirty" answer has been to use indicators but this has the difficulty of the very definition of indicators in that indicators may be present without the factors that they indicate or the obverse; the factors may be present but not the indicator. It then comes down to the effectiveness of any particular indicator and the probability of their accuracy. A more useful element is that indicators can be "furry and fluffy" animals that are popular and well known and thus easily communicated to the public and the non-expert decision maker. To me as a scientist this pragmatic approach carries with it the risks given above and also is subject to the "slime mould" effect. It is very difficult to generate enthusiasm or interest for something called a slime mould regardless of how important they might be in the totality of biodiversity and ecosystem function (and I speak from a painful experience in just this area of research!). A more "fluffy" version of the slime mould effect would be the "Wart Hog" effect!!

Scientists therefore need to assist the biodiversity decision makers by providing information that is both concise and accurate. I have in mind the study conducted over a 25-year period of the macrofungi fruiting in a Scottish Woodland. Two scientists recorded these fungi every year for 25 years and found that new species were occurring at the same rate after 25 years as when they originally started. They could provide a very long species list! What could be made of this list that in fact resembled so much of the biodiversity information extant? The sort of list that says 245 species of fly have been found on a site over the last 30 years but when examined most of the species were only found once and only 45 in the last year. Are they all there or not? How much effort went into collecting this information compared to information for other sites? What does this list mean in terms of the totality of the biodiversity of the site compared to any other? How important is the fly biodiversity in the totality of the site's biodiversity? How does this list relate to the socio-economic factors that form the background to decision making?

I would suggest the way forward might look like the following:

- Sites need to be scoped in the same way that EIAs and SEAs are scoped;
- A generalist ecologist looks at the site and suggests the most useful elements of the total biodiversity to be studied. These elements are then assessed in a standardised way such that the site can be compared with any other. That indicator groups might be used in this latter stage is possible but can lead to the undervaluing of other taxa and the difficulties given above.

Questions in this approach would be:

a) What is the appropriate time span and season for the studies?
b) Where do we get the generalist ecologist?
c) Can we compile a series of vegetation indicators for scoping a study?
d) How do we deal with obscure or taxonomically difficult groups that are nonetheless part of biodiversity e.g. nematodes or slime moulds?
e) What do we do with all of the historical records that do not conform to the new data?
f) How are we to decide what are the standardised protocols for making the numerical biodiversity assessments?
g) Can we agree on the relative importance of the biodiversity indicated for the groups studied?
h) Can we link this sort of approach to the politico-socio-economic background of the decision makers?

Just a few questions!

I have made a start to this process with standardised methods for macrofungi, bryophytes and spiders (and soon land molluscs) but this work needs to be connected into the decision-making processes to bring clarity and transparency to the aid of the decision-maker.

**Education and diversity**- Caspian Richards, Macaulay Institute.

KEYWORDS: Intrinsic value, diversity, communication, environmental education

SUMMARY: The author argues that there is an inherent tension between a search for universal values such as a sense of the intrinsic value of all living things, and the notion of cultural diversity where different values are celebrated. Biodiversity conservation research should aim to determine which aspects of human experiences of nature have the potential to develop into universal values, and which are necessarily diverse.

The philosopher Immanuel Kant devoted much of his thought to the question of how political structures could transcend the national units that fought amongst themselves in his day in order to pursue fundamental ethical principles he believed would be shared by all of humanity, if only all of humanity lived in conditions which allowed them to think properly about ethical issues. At the same time, he was also interested in the apparently contradictory question of cosmopolitanism, which we might perhaps call diversity, consisting of an understanding of and respect for regional differences.

It seems to me that this describes perfectly the two kinds of approach to biodiversity conservation that are being discussed here: on the one hand we have been talking about the

need to reach a common understanding of the intrinsic value of living things; on the other we are advocating the need to better understand different conflicting utilitarian concerns as they apply to specific conservation projects or policies with a real and practical impact. As with Kant's programme, there is a tension between the two - we applaud the principle of diversity of ideas ('culture') as well as of life-forms, but we also hope to persuade others to share our view that living things have an intrinsic value, thereby reducing the diversity of ideas by finding common agreement. This is, I would suggest, one of the main reasons for misunderstandings between natural and social scientists in particular: natural scientists often tend to look to advance the former programme, trying to gain acceptance for their own sense of the intrinsic value of living things (hence the talk of e.g. environmental education); social scientists, on the other hand, tend to bridle at talk of 'education', seeing it as indoctrination which fails to respect the diversity of human values and cultures.

I wouldn't want to give the impression that there are any easy answers to this dichotomy, and I'm sure that the kind of collaborative discussions and projects that Sandra Bell suggests would be invaluable in working to reduce differences between the two approaches. At the same time, however, I would suggest that discussions of this kind, aiming to develop a common approach to biodiversity, really need to be conducted on a much wider scale than among the academic community, as if there is to be any prospect of a wider recognition of the intrinsic value of living things then people will have to actively develop such a sense for themselves (through discussion, observation, contemplation) rather than having it communicated to them. One may nevertheless look for ways of facilitating the process, and here as researchers we have a lot to learn from the best teachers as well as from certain religious movements etc.

To my mind, then, the most urgent research need is to better understand how such a sense of the intrinsic value of living things is developed. This means firstly looking at the conditions that facilitate or prevent its development. Environmental education programmes, provided they are based on the kind of education which looks to develop faculties rather than to teach doctrine, can help to provide some answers, but we also require a sociological understanding of the relationships between e.g. poverty and the experience of nature which goes beyond statistical correlations to look at causes. The question of shared experience is also critical, and as Sandra has proposed, one which collaborative research can help to foster among researchers. Working with each other, but also (especially) with people outside the research community will enable us to examine where and why commonalities and differences develop when people share similar experiences, and thereby to speculate as to what aspects of the human experience of nature might under certain conditions become universal, and which are necessarily diverse. That in turn will lead us to be able to better differentiate between those aspects of our understanding of biodiversity we should seek to discuss widely (which I believe will be of the order of the sense of the intrinsic value of living things), and those which will have only fleeting influence, but which may at times be used in order to persuade non-believers of the merits of particular projects (and here I would place most 'utilitarian' arguments).

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**Biodiversity and Local or Native inhabitants: How to Increase Mutual Benefits**- Alpina Begossi, Nepam Unicamp.
KEYWORDS: Sustainable reserve, extractive reserves, governmental institutions, conservation plans.
SUMMARY: One of the main challenges for the conservation of the biodiversity is to include, in management projects or plans, the population that already lives in high biodiversity areas.

Studies on riverine inhabitants of Amazon rivers, such as Juruá, Negro, as well as the Araguaia-Tocantins Basin (Begossi & Hens 2000, Begossi et al. 1999) and on coastal fishermen of the Atlantic Forest coast (Begossi et al. 2002, Begossi et al. 2001) have shown their uses and rules concerning the local natural resources.

Certainly, not all forms of uses of natural resources depend on local established rules (or customary laws), and some technologies used depend on maintaining a low population density in order to be considered ecologically safe. But in places where we find rules concerning the use of natural resources, these rules should be taken into account and considered in conservation plans.

Examples of such rules are:
- Informal division of fishing areas, decreasing impact per area;
- Use of a high diversity of vegetal resources, diminishing impact per species;
- Food taboos, possibly diminishing impact in game or fish species.

In a megadiverse country (such as Brazil), governmental institutions should be more concerned in:
- Finding out what kind of resources are used and extracted;
- Finding out the local rules;
- Consulting researchers in universities that carry out research in high biodiversity areas;
- Establishing legitimate contact with local institutions, avoiding the common top-down approaches currently carried out in most Brazilian sites.

There are successful examples in the Amazon that have been taking into account the suggestions given above, which are the Sustainable Reserve of Mamirauá, led by the Sociedade Civil Mamirauá, and the Upper Juruá Extractive Reserve, led by the Rubber Tapper National Council. The definition of a Sustainable Reserve includes (www.mamirauá.org.br):
- The maintenance of the local population that participates in the management of the natural resources and in the reserve surveillance;
- The possibility to manage plants and animals based on solid scientific research;
- Flexibility to change economic strategies according to markets;
- Maintenance of private property;
- Implementation of programs that enhance the life of the local population;
- The establishment of partnerships with governmental and non-governmental organizations for developing programs for the sustainable use of natural resources.

In the case of Extractive Reserves, there is a high variety of forms in Brazil, but a few should be considered as the result of legitimate processes, as was the case of the Upper Juruá Extractive Reserve (Begossi et al. 1999). Recently, diverse top-down extractive reserves have appeared in coastal areas, where there is no local prior demand for conservation, and sometimes, neither a local organization. The success of conservation will depend upon the perception people will have on the possibility of resource scarcity, on their local demand or organization for that, on the use of local rules associated (or that could be associated) with conservation measures, with the interaction with research institutions, and with the support from governmental agencies for measures that conserve the natural resources.

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**Distributed Economies- a strategy for qualitative regional development-** Allan Johansson, Lund University and the Technical Research Institute of Finland (VTT).
KEYWORDS: Sustainable development, local production, distributed economies, quality of life.
SUMMARY: The author discusses the Distributed Economies concept as a way to bridge the gap between enhanced economic development and reduced material consumption, promoting regional development and an improved quality of life.

In addition to its more immediate practical applications, environmental concern has functioned as a proxy for a more profound concern in society, relating to ethics and quality of life issues, loosely brought together under the notion of sustainable development. Sustainable development, however, contains the contradictory elements of; on the one hand, enhanced economic development largely based on improved production efficiency through technological advancement and, on the other, reduced material consumption. The first has

translated into increased unemployment while the latter, in spite of efforts towards a new regime of eco-design (shift from products to services and intelligent products) has remained largely unfulfilled.

In an effort to bridge the gap, the Distributed Economies concept is proposed as a strategy where regional development, with improved quality of life is brought in as a guiding element. The concept uses as starting point the particular qualities of a region, geographic as well as cultural, and brings in new scientific knowledge to make better use of local skills and assets. It is primarily to be seen as a tool for bringing advanced scientific knowledge directly in contact with small and medium sized enterprises (SME) with the expressed aim of bringing about significant quality improvements in the local production scheme, through putting into practice new technology as well as synergies between local enterprises and the community as a whole. The regional focus also makes it possible to create innovative solutions making maximal use of natural resources without compromising quality of life issues, such as advanced product development based on local biological production systems, and high quality food production. The aim is to look for flexible solutions that can rapidly profit from modern scientific advancements as well as changing needs in the outside market. In the extension the various regions can obtain an economy of scale through networking rather than sheer production efficiency, with the entire regions as "products".

By having a "distributed economies" perspective it is believed that new business ideas and product concepts can emerge which effectively addresses the issues of life-cycle concern and material flows at a regional level. The regional base offers interesting strategic opportunities for identifying new internal synergies, building new capabilities, introducing change processes and re-defining dependencies (economic, social and technological) to the larger production system (global). Instead of pursuing a centralised and generic approach, the potential to open up new strategic possibilities for transforming industrial product systems based on specific needs and possibilities of regions.

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**A need for a standardised approach in biodiversity assessments**- Kajetan Perzanowski, Polish Academy of Sciences.

KEYWORDS: Biodiversity value, Natura 2000, management systems, anthropogenic pressure.

SUMMARY: Following a concept of biodiversity as an universal, special value of the biosphere it is necessary to elaborate a universal approach allowing to compare biodiversity retained in the same or various types of habitats being under different anthropogenic pressure.

To suggest the most important directions in biodiversity research, in order to improve their scientific quality, it is first necessary to clearly define the term itself. As it has been frequently pointed out, biodiversity is a convenient, even "politically correct" concept, understood and applied intuitively as having a universal, measurable value. Because of it usefulness, it is even occasionally possible to see a tendency towards its excessive use, e.g. when somebody speaks about biodiversity in a country.

It has to be accepted that although any diversity within biological systems can be generally referred to as biodiversity, for the purpose of comparative research, it is necessary to limit this concept to a framework can be measured in units reflecting a value of actual biodiversity level. It is fairly obvious that an approach to measure biodiversity as a number of biological categories (species, genomes or communities) per area unit, may serve only as quite self-evident comparisons, like saying that the level of biodiversity in the tundra is lower than in a rain forest. It is also clear that such a measure does not reflect a true value of biodiversity in different ecosystem types, not to mention its usefulness to compare a degree of biodiversity retention among regions being under various systems of land and resource management, or a level of biodiversity retained in anthropogenic habitats. Therefore, assuming that natural habitats (in practice almost gone by now in contemporary Europe) had an optimal level of biodiversity, there is a need to find a system allowing evaluating a relative value of biodiversity remaining in presently existing habitats.

Introduction of the Natura 2000 Network, as a universal system to maintain biodiversity of bio-geographical regions, may serve as a basis for comparison of actual biodiversity levels throughout Europe. For this purpose, for every habitat type recognised under the Natura 2000 system, it would be necessary to make an assessment of potential biodiversity level (under hypothetical natural conditions) in an agreed, standard way. Such a standard should be universal enough to be applied for the whole range of European habitats and not too complicated in order to be used for further routine monitoring.

The actual level of biodiversity measured in Natura 2000 sites would therefore be a fraction of the potential biodiversity level estimated for a relevant habitat type. That would allow for a direct comparison of retained biodiversity in the same habitat categories along the continent, but also to assess the level of retained biodiversity in various habitats being exposed to the same economic system, i.e. to compare a sensitivity of different habitats towards certain types of anthropogenic pressure. If extended over semi-natural and even anthropogenic habitats, this approach could as well serve to compare the level of biodiversity retained in such man-made systems as spruce plantations or potato fields in various European countries i.e. to measure the effects of different management practices upon the quality of human environment.

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**European Union conservation policy and local perspectives: the Cyprus case-** Marina Michaelidou, Cornell University.

KEYWORDS: Rural development, community participation, local values, Habitats directive.

SUMMARY: The author discusses how local perspectives need to be taken into consideration during the implementation of EU conservation policies.

The enlargement of the European Union (EU) presents new challenges for nature conservation and rural communities, particularly for the recently acceded countries. These countries are faced with the difficult task of conforming to EU conservation policies, while taking into consideration local socio-cultural values and concerns on the other. In 2002, a qualitative inquiry involving 112 individuals from three mountain communities located in the Pafos Forest of Cyprus was implemented to explore how local people value the natural environment and how they perceive EU conservation policies. In addition, local interest in participating in the development of conservation plans was assessed.

The three selected communities have traditionally depended on the forest to sustain their livelihoods. Today, like many rural communities across Europe, these mountain villages are facing decline, due to the lack of viable employment opportunities. The inquiry revealed that local people have great respect for the forest. People appreciate the historical contribution of the forest towards sustaining their lives and livelihoods during times of poverty, drought, and war. The local appreciation towards the forest is not limited to the direct benefits of food and employment, but also extends to the ecological, aesthetic, and cultural significance of the forest.

The inquiry further revealed that local people face EU conservation policies with skepticism and are concerned that these policies will negatively impact their lives. Many people argue that the EU seeks to enhance forest protection, at the expense of local practices, such as agriculture and timber felling. For example, through the implementation of Habitats Directive in Cyprus, which is EU's main policy regarding nature conservation, a lot of emphasis has been placed on the promotion of ecotourism, as an alternative occupation for local people. Ecotourism is pursued by public agencies in Cyprus in the belief that it will be more beneficial for nature conservation. Local are concerned about this strong emphasis placed on tourism, because tourism revenues are often inequitably distributed and opportunities are mostly captured by large tourist companies in urban centers. Furthermore, local people fear that the decline of traditional practices, such as agriculture and animal husbandry, does not only negatively affect their communities, but is also harmful for the forest. Finally, local residents indicated their strong desire to have more input in the design of policies that affect their lives.

It is suggested that during the implementation of EU conservation policies in Cyprus and other countries that have recently joined the Union, local government agencies should work with village institutions so that they do not exacerbate the decline of rural communities. Instead of placing a priority on the sustainability of habitats and species, these agencies should re-direct their efforts towards maintaining both cultural and biological diversity. Rather than deciding what occupations are compatible with nature conservation and imposing them upon local people, countries implementing these policies can work with rural people to determine what occupations are suitable and desirable for them and their culture and pursue those occupations, along with nature conservation.

The different needs and aspirations of people across generations may require a pluralistic approach in dealing with mountain community viability and not a focus on a single occupation, such as ecotourism. People in mountain communities, like those of the Pafos Forest, support forest and wildlife conservation, but at the same time wish to sustain their villages. They will therefore be more sympathetic of policies that address the viability of their village communities together with the viability of the forest, than of policies that ignore their overall well-being. Only through citizen participation and an emphasis on both cultural and biological diversity will EU policies succeed in meeting their objectives. Finally, the decentralization of EU conservation policies would better enable the incorporation of diverse local values as they apply to different regions of the EU.

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**How can we integrate our knowledge into new technologies, innovative plans for local development and biodiversity conservation?-** Konstantinos Hatzidakis, Member of the European Parliament.

KEYWORDS: Development, environment, tourism, sustainable development, structural and cohesion funds.

SUMMARY: There is an increasing move towards the promotion of environmental protection for increased development. The author illustrates this point by looking at local development, eco-tourism, the Structural Funds programmes and Cohesion Fund projects. He also emphasizes the need for a radical change in mentality regarding the real value of natural resources conservation, especially in Southern European states.

In the past, it was widely believed that development could be achieved only at the expense of the environment, leading to the over-exploitation of natural resources, atmospheric and marine pollution, destruction of the environment by waste… However, this theory is long played out. The notion has been steadily gaining ground that development and environment are not necessarily incompatible, but they may exist in harmony and complement each other, so that the promotion of one benefits the other and vice-versa.

Hence, it is true to suggest that promoting measures of environmental protection can further advance development. The more we try to preserve biotic resources and enhance environmental conditions, the more sure we can be that development will follow suit. This is particularly evident with regard to local development, and it can be illustrated in many ways.

Tourism constitutes a prime example in this respect. Since nobody would wish to go swimming in a polluted beach, for instance, it has become a major concern for local communities to keep their beaches clean and environmentally inviting. From another perspective, the rapid and spontaneous development of tourism, which is meant to boost local development by ensuring an adequate tourist infrastructure, can very easily lead to the opposite effect: all the more tourists appeal for "quality" tourism, which can be excluded on those cases. This trend is also reflected in what is known as eco- tourism, a rapidly expanding sector. The conservation of natural environment is the means to advance this eco-tourism, which implies further local development.

Moreover, a region with proper environmental conditions is certainly more attractive to investors than one with a damaged environment. Similarly, over-exploitation as well as degradation of the natural resource base can have severe consequences not just for the environment but for any economic activity in general, and investments in particular. Clearly,

a good implementation of sound environmental programs improves its development prospects.

This idea of sustainable development has been incorporated in the EU's cohesion policy. The implementation of all Structural Fund programmes and Cohesion Fund projects should now be consistent with sustainable development and Community environmental rules. The notion of the "greening" of structural funds implies that the respect for natural environment is a prerequisite for the elaboration of all programming documents and the implementation of relevant projects. The Cohesion Fund itself finances actions in the transport infrastructures and environmental sectors at a ration of 50-50. There is, thus, tangible proof that the EU has positively understood the environment and development as harmonised objectives, and works actively to assure these goals. Still, there is great room for progress.

Finally, there should be a radical change in mentality as regards the real value of natural resources conservation. Southern European states, in particular, should realise the need to primarily allocate funds to environmental projects. In this sense, a sound use of the structural funds constitutes a unique opportunity for those countries, as it will soon be the case for the newcomers to the EU. The view should rightfully prevail that biotic resources can be a major source of development.

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**Closing comments**- Andreas Troumbis and Yannis Matsinos (E-Conference chairpersons)

With the end of our e-conference that lasted for a full 3 week period let us take the opportunity to thank you for your contribution and your interest that made our endeavor a success! As already announced, the opinions submitted will be presented and discussed after a stage of synthesis in the forthcoming EPBRS Meeting next month in Lesvos, Greece. The final document resulting from your contribution will be sent to you soon after the meeting.

Summaries of the 3 sessions have been posted, where the major points raised during the discussions are highlighted. However, the major and novel element of this conference is the omnipresent need expressed by scientists to explore paths connecting their research strategies and epistemological method to a broader ethical perspective. The theme of biotic resources was supposed to explore the limits of the utilitarian argument as well as its usefulness regarding the ongoing societal 'mutations' initiated by a deeply transforming society, economy and understanding of environmental determinism. The message I got is that scientists are not longer 'satisfied' in the traditional role of procuring knowledge and tools to the society for informed policy-making. Rather, they ask for increased collaboration, cross-fertilisation and possibly integration between different perspectives, disciplines, scales and methods for coping with the challenge of global environmental change.

In other words, what appeared an unnecessary burden, driven by the political-correctness of the Commission five years ago, seems to be a pre-requisite today. Is this a sign of capitulation of scientists in the 'fight' around the two cultures' gap? Probably not! Biodiversity and environmental science were (are!) typically meta-science, with all advantages from the multitude of approaches and concepts coming from their constituent parties, but also several pathologies caused by the methodological chaos and sometimes ignorance of the foundations of individual disciplines.

I would like to think that we live the birth of a real biodiversity and environmental science, where the primary focus will be the understanding of complex environment-society interactions, the identification of driving forces for change and the exploration of development trajectories that should have a significantly smaller burden on the environment.

Marbena Joint Session:

**Does marine biodiversity really matter?**- Anastasios Eleftheriou, Institute of Marine Biology of Crete.

During the first phase of the third MARBENA e-Conference, substantial evidence was submitted pointing to the fact that marine biodiversity has been changing in the Mediterranean and that this change matters, not only from a scientific point of view but for a host of reasons (economic, social, ethical, etc). A number of examples of these changes have already been demonstrated: the invasion of new species, the displacement or disappearance of the indigenous fauna and flora, the continuous decrease in fisheries catches, and the destruction of habitats. It was also shown that various anthropogenic agents (human population growth being the first in order) associated with climatic change, are regarded as the major drivers of biodiversity loss.

The fact that, although Mediterranean marine biodiversity can be considered as the best studied in the world, our scientific knowledge still cannot give adequate support to managerial and political decision-making is an issue that has emerged in the first phase of the conference. Yet, that our scientific knowledge of Mediterranean marine biodiversity, which has been characterized by major gaps, such as lack of information on deep-sea biodiversity and on biodiversity distribution at different scales, lack of information on long-term biodiversity trends, the need to promote coupling of classical and molecular techniques for studying biodiversity and our limited knowledge on marine biodiversity and ecosystem functioning, has emerged as the trend, commonly shared by almost all participants.

Consequently, we, as scientists, are in the invidious position of being able to detect some of the changes leading to biodiversity loss, these being primarily detectable at the species level at least on a local scale, though we are still unable to detect the changes taking place on the regional scale and at all levels of marine biodiversity. However, both changes in marine biodiversity and the unknown information on the Mediterranean and Black Seas marine biodiversity may well imply consequences, which need to be evaluated in order to identify impacts on the marine environment and the associated social and economic systems. The latter concept has been recently considered as the cornerstone for the conservation and sustainable exploitation of the marine environment.

Valuation, of course, may include both direct economic value to resources (goods) and indirect ones as irreplaceable regulators of ecosystem vital functions (services), as well as ethical and aesthetic values.

At this stage, I do not intend to formulate the discussion by asking specific questions, as this is the first time that such a valuation will be attempted for the entire region. Thus, I prefer to remain with the questions formulated for this session:

- What is the value of change of marine biodiversity?
- What can we do to know the presently unknown?
- What are the consequences and costs of not knowing?

Some ideas referring mainly to the second question have already been expressed in the course of the first phase of the conference, including the formulation of MPAs, of common protocols for the monitoring activities and the introduction of international initiatives to the region, which could form an umbrella project to this challenge.

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**Some answers**- Ferdinando Boero, University of Lecce.

Here are my answers to the questions posed by Tasso:

i. What is the value of change of Marine Biodiversity? What is the meaning of value? Is it the gain that we can get from it? or the loss? There can be valuable changes (i.e. positive) and not so valuable changes (i.e. negative). A non valuable change was the decline of Tapes decussatus (so that we Italians had no longer the opportunity to have spaghetti con le vongole). A valuable change was the introduction of Tapes philippinarum (spaghetti con le

vongole again!). If we look at things in this way, if a change is in our favour then it is good, if it is not, then it is bad. Maybe the Eastern mediterranean was poorer than the western mediterranean because its conditions are different and, since the species that enter the Med have to arrive from Gibraltar, they had to pass an ecological filter that prevented tropical species to arrive at East, where the potential conditions were good for them. The opening of the Suez canal maybe let in species that were preadapted to those conditions, filling an ecological vacuum and forming what Por called the Lessepsian province. In this case the inflow of species was positive, and an ecological semi-vacuum started to be filled, increasing diversity and also economic yields.

ii. what can we do to know the presently unknown? This is a tricky question. Biodiversity is defined as a three level phenomenon. The easiest thing to do is to identify community types, and related habitats, and map them. In the Mediterranean, Peres and Picard gave a good example of how this can be done for the benthos. Dealing with plankton and nekton is a little bit more difficult. RAC-SPA provided a list of habitat types. We do not have the mapping of these habitats. It has been argued that focusing on species is a sterile enterprise, since we do not know most species, whereas, if we protect the diversity of habitats we protect also the diversity of species. I agree with the operational view. But I do not agree that knowing species is not so important. I think that we have also to know all species, we have to answer Bob May's basic question: How many species are there on Earth?

Astrophysicists claim that it is important to count the stars, and they obtain outrageous amounts of money to do so. If somebody asks them what is the use of all this, they say that this is a rude question, posed by insensitive people who deny the value of our sake for knowledge. It is our human nature that pushes us to investigate. OK, there are much more reasons to explore biodiversity at a species level than to count stars. Let's stop questioning the value of our work. The third level is that of genetics. This is to be developed too, to answer specific questions, like the viability of populations or the provenance of aliens.

iii. What are the consequences and costs of not knowing? This is like asking what the consequences of ignorance are. Not knowing is simply ignorance. How can we say if we do not know? We have many examples of apparently "useless" species that all of a sudden become important. Sometimes we are asked: where do they come from? Were they always here in small numbers, so that we did not realise their presence? Most of the time we do not know. I received money to study the outbreaks of Pelagia noctiluca in the Eighties. But when Pelagia disappeared again, the money disappeared.

We study things when they happen, and we usually start to study them when the conditions that determined them do not occur anymore. So we cannot explain. What is the cost of not being able to explain? The cost is that management is based on ignorance. I must go back to chaos, and to the butterfly effect. One thing is that the beating of the wings of a butterfly at Bombay can cause a thunderstorm at New York, but another meaning of this metaphor is the shape of a model. You can have a graphic model with a recurrent path, going in an elliptic way. The pattern goes on over and over again then, all of a sudden, it changes and goes into another path, with another ellyptic pattern, connected to the previous one by a single point. The two ellypses look like the wings of a butterfly. We focus on regularities, but the important thing is that point in which the system changed shape. That might be the ballast waters containing the inocule of Mnemiopsis in the Black Sea. Or the opening of the Suez canal. So, my answer to the cost of not knowing is that we cannot afford ignorance, both as a managerial issue and as a cultural issue. Not knowing is against human nature, our mission is to fight ignorance. Of course identifying priorities.

But as long as our governments give money to search for extraterrestrial life, then I dare say that biodiversity research, at all levels, has a greater priority than that.

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**In defence of Ignorance-** William Silvert, IPIMAR

Perhaps there is nothing that irritates politicians and managers more than a scientist who says that we don't know enough, we need more research. I like knowledge as much as anyone, but

we have to accept that the amount by which our ability to make good predictions grows is a decreasing function of how much we know, and we can reach a point where no matter how much more we learn, we cannot describe the functioning of the system any better.

The butterfly effect is a good example. While we may be able to trace the trajectory back to determine which butterfly "caused" a hurricane, we can never predict that a given butterfly will generate the next "big one" - and even if we eradicate all the butterflies in Australia, there will still be storms.

I doubt that we will ever be able to predict with certainty the consequences of environmental change, but we can assess the risks and advise on those. For example, we know that useful pharmaceuticals are most likely to come from toxic species, so the risk of missing the cure for cancer is greater when a cone shell goes extinct than when a guppy does. Of course this does not imply that we know which cone shell contains the secret ingredient!

Sure it would be nice to have a list of all the species in the world (a list that would have to be revised several times per minute if we include all the microbes), but I am not convinced that the fact that most of the world's species have not yet been scientifically identified is such a major impediment to our ability to make sound recommendations on the management of marine ecosystems.

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**Recent status of the Adriatic ichthyofauna**- Jakov Dulèiæ, Institute for Oceanography and Fisheries and Lovrenc Lipej, Marine Biology Station, Slovenia

The Adriatic Sea is relatively well studied, with a centennial tradition of biological research. However, new taxa of marine flora and fauna are still being recorded each year, including numerous new first records of fishes have been made in the last thirty years in the Adriatic, including non-described species. The most important reason for the increase in preceived biodiversity of the Adriatic ichthyofauna is possibly the discovery of a large number of species outside their usual area of distribution. This may be due to an increase in the research effort (especially in the southern Adriatic basin), or to the use of newer techniques (visual census, underwater filming, use of narcotics, etc.) which allow the exploration of otherwise inaccessible habitats (Quignard & Tomasini, 2000).

By such methods new species of gobiids were discovered in the last thirty years, such as Speleogobius trigloides, Didogobius schlieweni and Gobius kolombatovici, all in the Northern Adriatic area (see works of Miller, Kovaèiæ, Ahnelt, Patzner, Zander & Jelinek and others). Most new records made using these newer techniques are of the cryptobenthic fishes, those that always live inside burrows (such as caves, cavities, holes, clefts) or below cover (stones, boulders, shells) and are therefore not visible from above (Miller 1979, 1996; Patzner, 1999). Recently adopted techniques, such as visual census, non- destructive diving (Harmelin, 1987; Harmelin-Vivien & Francour, 1992), and the use of narcotizers, enabled recording of some apparently “rare” benthic fish species in the Adriatic.

However, few Adriatic institutes are currently using such techniques, and the majority of ichthyologists are unfortunately, only interested with economically important fish species. The mentioned increase in number of species is certainly correlated with climatic and oceanographic changes and to a lesser extent to biological invasion, as well. During the last decade, several papers have been published on the occurrence of new fish species in the Adriatic Sea, bringing up a number of the Adriatic fish species to 430, belonging to 118 families. Some of almost 30 new species to the area can be attributed to the northward spreading of southern, thermophilous species such as Thalassoma pavo, Xyrichthys novacula and especially, Sparisoma cretense. Up to date, seven species of Lessepsian migrants were recorded in the Adriatic.

Paradoxically, the Adriatic sea considered by many scientists as a pioneer area in ichthyological research with centennnial tradition, seems to be, at least at some levels, rather scarcely studied.

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**Some Results of Nematode Fauna Investigations**- Kulakova Irina, National Academy of Science of Ukraine.

Total amount is: 29 samples of fouling and 32 dragger's samples. At present time fauna of the Black Sea nematodes comprises more than 200 species. The most diverse fauna of nematode has been recorded in the Crimea and Caucasus. In the northwestern part of the Black Sea the nematode fauna includes 93 species. The maximal density of nematodes forms at the open regions of the northwestern shelf (average density 530 000 ind·m-2, biomass 1,4 g·m-2), minimal – in a most polluted zone (average density 83 000 ind·m-2, biomass 0,2 g·m-2) (Kulakova, 1989, 2001, 2001a). At present time the fauna of the free-living nematodes in the basin of Odessa port comprises 30 species, belonging to 4 orders. The question about geographical distribution of the free-living marine nematodes until the present time is unclear. In 1920 – 1930s, many specialists considered that nematodes were cosmopolitan organisms. There have been assumptions that the zonal – climatic factors have no influence on their distribution (Steiner, 1915; Kreis, 1934). However this point of view has been contested by Chitwood (Chitwood, 1936a, 1936b, 1937, 1951, 1960) on the basis of differences between the species recorded along American coasts and those along the European coast. Some modern authors (Gerlach, 1955; Meyl, 1956, 1957; Timm, Wieser, 1953) are share this view and consider that the number of cosmopolitan forms among the free-living marine nematodes is much less than it was considered earlier.

It is hard to trace the distribution of the species because of the different level of studies in different regions of the World Ocean. Regarding the marine nematodes this question is still at the stage of investigation. It is of interest to clarify the zoogeographic affiliation of some species. When comparing the fauna of nematodes of the surveyed area with other seas it has been determined that port fauna (including northwestern part) have much more similarities with the fauna of the Mediterranean Sea (number of common species – 73 %) than with the northern seas of Europe (42 %). The nematodes species, that are common for the surveyed basin and for the Atlantic coast, costal zone of Central and South America, tropical seas made up 23 %, for Antarctic and Subantarctic – 1–3 %. This ratio assumes that distribution of the marine nematodes submits in general to same zoogeographical rules, as the distribution of all other marine benthic animals. All species registered in Odessa port are listed by I.N. Filipjev in the register of the nematodes species of the Black Sea (Filipjev, 1918 – 1922). On the basis of determination of the native species, most of the determined species have been ascribed to the native fauna. From the list of nematode species recorded in Odessa port four of them have not been recorded in other regions besides the Black Sea. The frequency of these species is 11 % from the total species frequency at the port; they do not form mass settlements. Five species are typical only for the Black and Mediterranean seas. From them only C. maeoticus was a mass species and was often recorded in Odessa port. Most of the species, recorded in Odessa port, have the vast areal. Besides the Black and Mediterranean seas these species have been recorded in the brackish waters along all European coasts, in the North Atlantic as well as at Arctic seas. Among them the mass species were S. pulchra, O. dujardini, O. ampylocercus. In the port area, 5 organisms of Nematoda were marked as species. Probably these nematodes will be known for the Black Sea. The reason of new species is small investigations but not invasion from the other parts of World Ocean. For predict of fauna changing it is necessary to have long term investigations material for the different regions. The following investigations could determine new species and decide the special ecological and zoogeographic problems.

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**North-western part of the Black Sea (NWBS)**- Yuvenaly Zaitsev, Natioanl Academy of Sciences of Ukraine.

Really, the Mediterranean should be the best-studied basin in the world (Roberto Donovano). The Black Sea, which is a large low-salinity area of the Mediterranean basin, is also proof of this. Especially the shallow north-western part of the Black Sea (NWBS), including the Gulf

of Odessa (GO). This area resembles the Gulf of Trieste (described by Dr Serena Umani): it is controlled by riverine discharge and open Black Sea water advections, winds etc. From the late 1950s until today, continuous plankton and benthos investigations have been carried out especially by the Odessa Branch of the Institute of Biology of Southern Seas (Black Sea Biological Diversity. Ukraine, 1998). Since the late 1960s - early 1970s, the NWBS was subjected to strong man-made influences: eutrophication, transformation of coastal and shelf habitats (construction of new harbours, dredging, enlargement of beaches, coast-protection, urban concentration etc.), accidental and intentional introduction of exotic species and other kinds of anthropogenic impact. Because plankton and benthic communities in the area were well defined, we have proof of serious change in some ecological compartments (in reply to the question 3 of Prof. Ferdinando Boero). Normal (natural) changes and man-induced changes in the Black Sea ecosystem can be well discriminated and relevance of the later on the biota was investigated.

Anthropogenic eutrophication has an influence on the phytoplankton species diversity stimulating the development of dinoflagellates at the expense of diatoms with corresponding change in biomass. So, in the 1950s and 1960s the dinoflagellates in the NWBS accounted for 18.8% of the phytoplankton biomass, by the 1970s it accounted for 55% (Zaitsev & Mamaev, 1997). Eutrophication directly affects the species composition of bottom-living macroalgae by reducing the number of species with a low level specific surface (S/V), even leading to their disappearance (as with the brown alga Cystoseira barbata along the north-western coast), and the growth of the number of filamentous species with a high S/V values (Minicheva, 1993). Since Cystoseira barbata is a key species of the specific community (Cystoseira biocoenose), its disappearance entails serious consequences: disappearance of a coastal community, composed by 50-60 species of invertebrates and fishes. This community is important for the biology and ecology of coastal waters (Zaitsev, 1993). Blooming of phytoplankton in eutrophicated areas has an indirect effect on bottom-living algae, such as reduced water transparency. As a result, only algae adapted to dim sunlight survive at depths over 15-20 m, thus substantially limiting the species diversity of macrophytes on the NWBS. The case of the famous Zernov's Phyllophora field is very significant in this sense. In the 1950s, this field was still the largest aggregation of red agar-bearing algae of the Phyllophora genus in the world, occupying an area of 11,000 km2 in the central part of the NWBS with a total biomass estimated at 7-10 million tons. By the early 1990s the field was a mere 500 km2 and its biomass did not exceed 300,000 tons (Zaitsev, 1992). Moreover, Phyllophora was the key species of a community known as the Phyllophora biocoenosis, which included about 110 species of invertebrates and 40 species of fish. A second Phyllophora field, so-called "small field", located in the same area (NWBS), but at a depth of 8-10 m still exists (Zaitsev & Mamaev, 1997).

Among other consequences of eutrophication in the NWBS are the replacement of large-size species of zooplankton (e.g. copepods), that dominated in the NWBS until the 1960s by small-size species, blooming of gelatinous species like Noctiluca scintillans and Aurelia aurita, appearance since 1973 of seasonal (summer-autumn) of hypoxic zones on the NWBS shelf (a consequence of sedimentation of large amount of phytodetritus) and mass mortality of bottom invertebrates and fish (Zaitsev, 1993). A series of consequences and impacts on biological diversity is connected with the accidental introduction into the Black Sea of exotic (alien) species (Zaitsev & Ozturk, 2001).

Due to a relatively low specific diversity in comparison with the Mediterranean (as a result of low salinity, hydrogen sulphide contamination of deep waters, many relic (Pontian relics) and endemic species) the Black Sea has a low "biological immunity". A consequence of this is the naturalization of many exotic species, which in the absence of its antagonistic species are free from an practically unlimited growth of population with an adequate impact on native species (Zaitsev & Ozturk, 2001). Such is the case of ctenophore Mnemiopsis and gastropod Rapana in the Black Sea, whose behaviour in new habitats is quite different than in original waters and whose impact on commercial fisheries is very important. Existing data on habitat changes in the NWBS are crucial for changes in biological diversity and habitat conservation should be a priority in the marine environment conservation (answer to the

question of Prof. John S. Gray). Particularly it concerns "hot-spots" of high species richness. Especially when in the same habitats an accumulation of pollutants occurs. This is the case of contour (marginal) biotopes of the sea situated in its interfaces with atmosphere, shores, bottom and river waters (Zaitsev, 1986). These habitats provide favourable conditions for marine organisms but recently contour biotopes turn out to be the most contaminated marine habitats by chemical and radioactive substances. That is why the contour-living organisms are now among the most threatened species. More than 75% of species included into Black Sea Red Data Book (1998) are living in contour biotopes during all their life cycle or during a certain stage of onthogenetic development (Zaitsev, 1971, 1986, Zaitsev & Mamaev, 1997).

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**Reasons for not being too alarmist**- Ferdinando Boero, University of Lecce.

The fundamental book on biodiversity has been published by UNEP: Global biodiversity assessment. I have been asked once: tell me one species that became extinct from the Mediterranean Sea. Not locally extinct, or threatened. Extinct, like the dodo, I could not find one. Maybe there are one or two. I reported already that in my survey on the state of Mediterranean biodiversity no regional focal point could list a single extinct species. Besides the usual local extinction of monk seals. Or threatened species like Pinna nobilis and Posidonia oceanica. The catastrophic biodiversity loss might be a boomerang if we are not able to provide sound data about it. I studied date mussel fisheries along the apulian coast and I can tell you that this activity led to amazing amounts of habitat destruction, it is a catastrophe, but it did not put in danger (that we know) a single species.

So, please, let's not be catastrophic or we will lose credibility. I already said about Cousteau who, thirty years ago, said that the Mediterranean would have become a swamp in 20 years. The result is that now people do not believe in these catastrophic views anymore, and the politicians cannot be convinced as easily as they were before. Does anybody have a case of final extinction from European waters? Do we have a list of extinct species? Let's be serious. But maybe we can provide an estimate of surfaces of community loss. There are no more Posidonia meadows along the Adriatic coast of Italy. This leads to coastal erosion. Do we know if we are losing white coral communities? Or coralligenous formations? This biodiversity loss is the most important thing we have to quantify, in the immediate. I am sure that some species became extinct due to our action, but they were probably declining species that were not even described. There are very few species that we can drive to extinction apart from the usual whales and dolphins. Try to do it with flies, or with rats.... Mnemiopsis was more efficient in causing the decline of fish in the Black sea than we were.

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**The value of Marine Biodiversity- What you would pay for?**- Roberto Danovaro, University of Ancona.

I'm trying to reply to the question posed by Tasso Eleftheriou, tackling some points made by Boero. What is the value of change of Marine Biodiversity? What is the value of change of Marine Landscape? What is the value of species loss?

When we discuss the matter of costs, we had better open up the issue to those studying money seriously: the economists. Yesterday I posed myself this question: how to evaluate this? In my opinion the reply is: 1) either we do know more and we know how much we can profit of the existence of a species or of an habitat or landscape (that means we need to study more, and I think everybody agrees on this point); or 2) we could start with a classical market investigation. We create adequate questionnaires (open or closed) and we go around asking to people: What would you pay for not loosing the possibility of watching dolphins in the Mediterranean? Or what you would pay for having dolphins swimming in this bay? Or what you would pay for keeping this beautiful coastal/marine landscape? Nothing new, indeed, in USA they already started with a similar approach for some terrestrial habitats.

The results could be interesting and twofold: we could better understand the public perception of marine conservation, politicians could have a better idea of the value of marine ecosystems (not just fisheries!) and we could also understand how little we have been able to "educate" the world outside our labs on marine biodiversity matters.... Why not try?

**Values for humanity**- Lydia Ignatiades, Institute of biology (Demokritos).

Marine biodiversity matters because its values for humanity are very important: food, drugs, renewable energy, oxygen levels in the atmosphere, industrial materials, transportation and recreation are among the major values that can be devaluated along with the loss of biodiversity. The present unknown is the impact of human activities on biodiversity such as patterns of natural resource consumption, pollution as well as species introduction and loss. The sequences and losses of not knowing the importance of biodiversity might have dramatic effects on the marine ecosystem and therefore, on the well-being of humanity.

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**Knowledge and conservation priorities**- Samir Grimes, Institut des Sciences de la Mer et de l'Amenagement du Littoral

KEYWORDS: Marine biodiversity, protected species, knowledge.

SUMMARY: The author argues that the status of species is often decided on subjective grounds, and lists a number of research priorities in Southern Mediterranean states such as a species inventory, the role of species in sustainable development and possible threats.

Unfortunately, biodiversity is divided into two, if three very subjective categories. The first category is the biodiversity popular with scientists, economists, policy makers, media and the general public. These, as I am sure you will have gathered, are the "star" species that scientists often refer to as flagship species. The second group is composed of species that are less represented in the media but can be beneficial in certain ways. The third category is ecologically a little more marginalized and can be regarded as having a "minor" role.

This distinction between species is extremely subjective and one runs the risk of diminishing the role of unprotected species in the eyes of the general public. Together with their value, our ecological vigilance concerning the loss of marginal species and their habitat can be lessened. Research and conservation efforts are therefore biased, with action plans geared only towards the conservation of particular species and ecosystems. To take the example of the marine and coastal biodiversity in Algeria, the numbers of protected species is stable. Most species that are listed under annex II and III of protected areas in the Mediterranean have high population densities, even though a few species such as Pina nobilis, Patella feruginea and Centrostephanus logispinus are showing a slight decline. Similarly, there are no more monk seals in areas where they were once present (Habias and Rachgoun islands on the West Coast of Algeria). The problem of a species inventory still remains, with some species benefiting from increased funds for their conservation, whereas others, whose range is limited to Northern Africa, or even Algeria, are unknown to the general public and can become extinct in total anonymity.

Knowledge gaps in the Mediterranean are important and need to be addressed. We have to cooperate in order to improve our knowledge of species in the Southern Mediterranean area and reach a knowledge balance between Mediterranean countries. Research priorities include: a species inventory, species protection criteria, the threats present in each area, the role of species in sustainable development and local population stabilisation when dealing with important economic species...

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**Science for better governance**- Martin Sharman, European Commission

KEYWORDS: Role of science, uncertainty, precautionary principle.

SUMMARY: Policy makers need answers now, to questions that scientists are in (at least) two minds about. How should we approach this all-too-frequent dilemma?

Although it is not on the agenda, it seems to me that there is a key issue that this conference might want to address, which is how science contributes to governance, in day-to-day exchanges.

Policy-makers work on a different time scale from scientists. Policy-makers rarely have the luxury to look several years ahead for a possible solution to a problem - they very often need something that they can implement today (or tomorrow at the latest). Their decisions track phenomena (public pressure, drafts of documents, instructions from hierarchy, questions from parliament) in which change can be observed in days or weeks - and perhaps even hours. This often means a "quick and dirty" partial solution, perhaps based only on very shaky scientific observations. Biodiversity scientists, on the other hand, typically work to the rhythm of multi-annual funding and project cycles, as they track hugely complex phenomena whose changes may sometimes be confirmed only after many years - and perhaps decades or more.

Let us suppose that the EPBRS manages to work out an excellent strategy for biodiversity research. Good though the programme may be, nobody can possibly predict all policy requirements. So even if some policies are based on solid science, some will always be based on unsatisfactory evidence. This is in effect what the precautionary principle states.

Policy makers are used to working in a world of ambiguity and incomplete information. They can easily accept that sometimes the advice they receive, even from the best scientists in the world, is not much better than an educated guess. It is much more difficult psychologically for scientists, who seek to reduce ambiguity as much as possible and who balance probabilities as a profession, to provide advice from a knowledge base that consists of more doubts than facts.

Here is my question to you, dear reader: how might scientists properly handle responses to requests for advice when scientific knowledge is lacking? Should they say "here is the best guess I have at the moment, here are my doubts about my guess, and here is the costed description and schedule of work needed to provide a better-substantiated reply in 10 years' time"? Can we work out a "best practice" manual to help scientists to deal with RASKLs? (A new acronym: of course it means "request for advice when scientific knowledge is lacking".)

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**RE: Science for better governance**- Ian Davies, FRS Marine Laboratory.

Above all, the scientist must be honest. If he has to make his best guess, then he must be extremely careful that he is not reflecting personal or institutional prejudices. He should also be careful not to tend towards giving the answer that he thinks the policy maker would prefer to hear.

It is most unusual that such a reply can be accompanied by statement of a programme of work and a costing that actually results directly in funding. Inevitably, the scientist's view of the world and experience are different from those of the policy maker. Time scale is part of this, but perception of opportunities, risks, utility and priorities also need to be fully appreciated. Consequently, scientifically well thought out proposals can often miss the target because the scientist does not understand the position of the policy maker in the target scientific area, or in relation to other scientific areas.

A better route to a scientific programme that ultimately benefits society is to indicate to the policy maker that the scientist can see ways forward, and to offer to meet and discuss to agree the general direction of a subsequent proposal. The proposal then can be written and submitted to the right funding agency with some confidence that it will ring the right set of bells in the policy office.

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**Science and governance**- Ferdinando Boero, University of Lecce

In an introduction of university courses to high school students I crossed an engineer. He spoke before me. He said to the boys and girls: you give a problem to an engineer and he will find a solution. I had to introduce the faculty of science and I said: you give a problem to a scientist and he will find ten other problems. No wonder decision makers like engineers. The problem is (we like problems!!!): do the solutions really solve the problem? If you take coastal erosion, it is a solution to build walls in front of the coast. The whole coast of the Italian Adriatic sea is a wall. This beautiful solution brought not ten but one hundred other problems, after some time. By that time the decision makers forgot who caused the problem and called engineers again to provide solutions, while scientists remained confined in their Cassandra lament.

It is strange that politicians find money to explore outer space, looking for Martians. There is a research project (extraterrestrial life) that has been going on for 40 years with enormous investment and absolutely zero results. How come the funds are not cut? I have some answer but I do not want to go on much on this. Politicians want answers, but the way to reach answers passes through fundamental research. The foundations of the answers you ask are, by definition, in branches of science that are apparently "useless" but fundamental. I have already said what happened when politicians wanted us to give an answer on jellyfish blooms. They asked the question when the bloom was a problem, and lost interest when the blooms were over. And funds were cut. Then they are irritated if we do not have answers. Most of the time, however, there is no answer, if you want precise predictions.

Chaos theory (that I invoked so many times in this forum) is there to tell politicians that meteorologists can predict the weather at a very short term, and that it is impossible to give forecast over the long term. We would like to know if next summer will be arid or very rainy. Sorry guys, it is impossible. In our field, however, there are people who come out and say that they have the answer. The politicians go for them, even if they invariably fail. Look at the economists. They play the game. The best thing a politician can do is to have panels and hear different opinions. And then take a decision. Usually the guys who have answers are very active, looking for the people who ask questions, in order to get their money. The people who have more questions usually play with their questions, you have to look for them, they will not come pulling your arm to catch your attention. It is easy to find them, though. There is the ISI (Institute of Scientific Information). They can tell you who is publishing good work on the topic you are interested in. There are Scientific Societies. Ask them.

My experience in Italy, but maybe in Brussels it is the same, is that there are very "active" scientists in getting money by going to functionaries. They nurse them, invite them out for dinner, and become their friends. The others do not have time to do this. What I want to say is that, sometimes, those who might provide answers are not invited. I participated in several panels on biodiversity and realised that very few of the people in the room were actually studying biodiversity. At first I was shocked and withdrew. But I had to withdraw several times. Then I almost stopped going.

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**Aggregation in Marine Ecosystems**- William Silvert, IPIMAR.

I think it is useful to have this catalogue of differences between marine and terrestrial ecosystems, but I would add an observation that has significant implications for understanding marine biodiversity. Highly aggregated models have proved very useful in modelling marine ecosystems, and I think that this has implications for the way in which these ecosystems function.

In particular, size structured models in which organisms are characterised just by size work very well, and marine ecosystems have very similar size spectra with approximately equal biomasses in each size range (on a logarithmic scale - i.e., the biomass of organisms between 1 and 10 cm is roughly the same as that between 0.1 and 1.0 mm). This suggests that the role of individual species in determining the structure of marine ecosystems is relatively minor, and that the ecosystem determines the species in it rather than the species shaping the

ecosystem. In other words, an ecosystem is like a play - the individual actors are important, but it is the structure of the play that determines their roles.

This has major implications for studies of biodiversity. Whereas in terrestrial systems (or even semi-terrestrial, the polar bear is a recurring example) a single species plays a dominant role, there are usually several top predators in a marine ecosystem. Marine ecosystems are probably more robust in terms of their response to the loss of a few species, although this may not appear to be the case for humans who see commercially desirable species replaced by inedible "trash fish" and invertebrates.

There are also major differences associated with the links between primary production and grazers. We know a lot about forest and crop biodiversity, but algal biodiversity is quite another matter, further complicated by the existence of many kinds of harmful algae.

In short, our understanding of terrestrial biodiversity is not a great deal of help in dealing with marine biodiversity, and the political aspects of defending marine biodiversity are bound to be very different. And of course when we start talking about the political aspects we have to remember that whereas organisms that grow on land are a national resource, those that live in the sea are common resources and must be managed globally.

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**Fuzzy Management**- William Silvert, IPIMAR

Martin's call to scientists to become RASKILs (a slightly more pronouncable acronym) prompts me to bring up one of my pet interests, the use of fuzzy logic in environmental decision-making. Although one sometimes sees headlines in business magazines advising ambitious executives to be very precise, as "managers don't appreciate fuzzy logic", the reality is that decision-making in a complex environment can best be understood as an exercise in fuzzy control theory.

For example, a fuzzy rule might be "If a fish stock is endangered then suspend fishing". "Endangered" is a fuzzy term and it can take a long time for scientists to agree about it, but the fuzzy rule can be interpreted to state that if 4 out of 10 scientists think that the stock is endangered, reduce fishing pressure by 40%. Real applications tend of course to be much more sophisticated than this, but the language of biodiversity is pretty fuzzy to begin with, and trying to implement solutions only with precise numerical measurements may not be very effective.

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**RE: Science for better governance**- Lydia Ignatiades

When scientific knowledge for an environmental problem is known the scientists will certainly and clearly tell the truth to the public, the decision makers and the politicians about it. Actually, they should describe the problem in detail and its detrimental effects as well as the different steps, the time involved, and the budget for getting the scientific knowledge to solve it. This approach is more acceptable by the public than hiding the truth and promising quick solutions that might not be accomplished. It should be noticed that the practice of telling the truth is followed by scientists of other fields, e.g., the luck of knowledge in the cure of cancer is well defined by the scientists involved in cancer research and we all know that it will take a lot of effort, time and money before getting a successful solution to this problem.

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**Assumptions**- Ferdinando Boero, University of Lecce.

Christos and Tasso propose a series of assumptions to summarise our forum:
1. Diversity at higher taxonomic levels is much greater in the sea (fourteen “endemic” marine phyla, compared to one terrestrial)
The endemic terrestrial phylum is the Onycophora and does not occur in Europe.

2. A greater variety of species at a higher trophic level are commercially exploited in the sea. There is more than this. Man exploits natural populations only in the marine environment. There are no terrestrial animals and plants, in Europe, that are harvested from wild populations, whereas the majority of the resources we get from the sea derive from natural populations.
3. The marine physical environment is totally different from the terrestrial physical environment. OK, no further comment.
4. Dispersal of species may occur over much broader ranges than on land. There are many facets of this problem. Remember that many terrestrial organisms migrate (think of the birds). This apparently logical statement might lead to many counterintuitive facts, like the paradox of Rockall.
5. The main primary producers are very small sized and often mobile in the sea. This is true, but the turn-over rates are very fast. This leads to point 6.
6. The standing stock of grazers is higher than that of primary producers in the sea. This is true in a static situation (standing) but turnover rates contribute to justify how comes that those who eat are more abundant than those who are eaten.
7. Ocean productivity is on average lower than land productivity. If you take Valiela's textbook, marine Ecological Processes and go at page 29 there is a table related to production (not productivity) in various environments it appears that the greatest production is that of freshwater phytoplankton in nutrient rich waters, then there are corals, kelp & rockweeds, then benthic microalgae, then rain forests and so on. The picture shows that, even taking the surface of available space for that kind of production, the sea is incomparably more productive than the land.
8. High level carnivores often play key roles in structuring marine biodiversity. This is true, but remember that these carnivores are not necessarily large animals. Mnemiopsis is a more efficient predator than all cetaceans, birds (and men) that insist on the Black sea. And this is probably true for many other apparently inconspicuous top predators. We did not investigate this aspect enough, especially in the Mediterranean.
9. Marine biodiversity is the most exposed to pollution. Yes, everything goes to the sea sooner or later. But, in the sea, there are no ultra endemics like on land. There are little molluscs or little flowers that occur only on the tip of a given mountain: If you affect that mountain the species might become extinct. There is nothing like that in the sea.

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**Marine biodiversity and EU policies**- Lydia Ignatiades.

The policies to replace a) "our primitive" way of burning oil energy as well as b) our "aggressive" anthropogenic attitudes, are very promising and they will be the key factors for conservation of the biodiversity. These factors could be characterized as "long term" actions and they should be taken very seriously into consideration although they cannot be presently accepted by the politicians and decision makers as it was proved during the Convention on Biological Diversity. Thus, scientists should intensify their efforts in this direction along with all other appropriate actions (scientific programmes, educational policies, national and international projects) for conservation of biodiversity.

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