

Targets for biodiversity beyond 2010: research supporting policy



Report of an electronic conference, September 2009



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Preface

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

The need for co-ordination between researchers, the policy-makers that need research results and the organisations that fund research is reflected in the aims of the “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, to exchange information on national biodiversity activities and to disseminate current best practices and information regarding the scientific understanding of biodiversity conservation.

This is a report of the E-Conference entitled “Targets for biodiversity beyond 2010: research supporting policy” preceding the EPBRS meeting to be held under the Swedish EU presidency in Visby, Sweden, from the 28th September to the 1st October 2009.



Introduction

Peter Bridgewater, E-Conference Chair

Background

A commitment to protect and restore habitats and natural systems and halt the loss of biodiversity by 2010 was made by European leaders at the 2001 EU Summit in Gothenburg.

In April 2002, the Parties to the Convention on Biological Diversity (CBD) committed themselves (Decision VI.26) to a new mission which was “a more effective and coherent implementation of the three objectives of the Convention, to achieve by 2010 a significant reduction of the current rate of biodiversity loss at the global, regional and national level as a contribution to poverty alleviation and to the benefit of all life on earth”.

While the word target was not used in the CBD decision (rather it became the new mission), the World Summit on Sustainable Development (Johannesburg, 2002) included that CBD decision as a target to achieve, by 2010, a significant reduction of the current rate of biodiversity loss at global, regional and national levels as a contribution to poverty alleviation and to the benefit of all life on earth in its Plan of Implementation.

Following this history, in 2006 the UN General Assembly amended Millennium Development Goal 7 (Ensure environmental sustainability), by adding an additional Target 2: ‘Reduce biodiversity loss, achieving, by 2010, a significant reduction in the rate of loss.’

From its 2007 meeting the G8 group of nations have added biodiversity issues to the agenda. In the ‘Carta di Siracusa’ on Biodiversity, issued by the G8 ministers of the Environment, the Carta talks about a post-2010 common framework on biodiversity, but does not actually talk about a target.

Suffice it to say that none of these targets have been met, and the global biodiversity community is now addressing the post-2010 period. Final decisions on the way forward will be taken at CBD CoP10 in Nagoya, October 2010.

In 2004, at CoP VII the CBD decided to establish Focal areas and within them Goals and sub-targets (which were labelled as targets, thus confusing with the global Target). Full detail here is to be found at <http://www.cbd.int/decision/cop/?id=7767>

E-conference

The challenge for the e-conference was three-fold, namely:

- To assess the appropriateness of a global target to halt or reduce biodiversity loss;
- To review the existing set of goals and sub-targets and to propose new targets;
- To comment on the natural and social science research needed to verify such targets and the indicators necessary for monitoring them.

The e-conference focussed on three key questions, one per week of the conference – although of course there was overlap between these questions (and their answers!).

1. How can we use the experience of the existing 2010 biodiversity target and its goals, sub-targets and indicators to set updated (or new) relevant, rigorous, balanced and legitimate target(s) and indicator(s) post 2010?

- Is existing social and natural science knowledge enough?
- Do we need better science-policy interfaces to manage target creation and measurement?

- What new knowledge do we need?
 - Are there examples from other environmental targets that have been successful?
 - Should the targets all be for the same time period i.e. a decade, or should there be flexible timelines for them?
2. What research do we need to set and monitor biodiversity targets for the future, and the subsequent management of biodiversity? (Note: the research needs were more about those which were needed to develop and implement policy, not to advance pure science)
- For development of policy (to determine the future conservation/use/management of biodiversity)
 - For science which is policy relevant
 - To link with climate change (and other global changes)
3. Are there specific conflicts between existing or potential goals, sub-targets and targets or their associated indicators for biodiversity change?
- Marine – terrestrial; should there be different indicators?
 - Socio-economic goals and their impact on biodiversity
 - Ecosystem services – is this the same as biodiversity, a surrogate for it or something different again?
 - Climate change and biodiversity indicators
 - How do we manage these conflicts?

In addressing all 3 questions we needed to bear in mind – what are the communication needs to ensure messages get across to decision makers, and the wider public?

Underlying all of this are real questions concerning how well we have established research that addresses the integrative questions of biological diversity – which is a hierarchical concept that needs to be addressed as such. Research on species is not research on biodiversity; it is research on species, only one element of biodiversity. The DIVERSITAS programme was established with the aim of promoting such research, yet still there is little integrative research emerging.

As we approach 2010 we need to refocus our efforts on this theme of integration, for it is that, above all else, which may allow us to define more appropriate targets and ways of measuring our success at reaching them – or even allow us to question if we need such targets at all, to help manage the reality of biodiversity change in the decades to come. Our e-conference therefore had a wide reach, combining both natural and social sciences.



Summary of contributions

Fiona Grant and Juliette Young

Summary of contributions: Week 1

Stefan Leiner began discussions by highlighting the value of the 2010 target, as well as some of its key limitations including the lack of a baseline against which progress could be measured; the lack of a unifying currency against which progress toward the 2010 biodiversity target could be measured; and the failing of the target in reflecting important emerging issues such as the dimension of ecosystem services. Allan Watt agreed with Stefan Leiner's call for incorporating ecosystem services in future biodiversity targets and referred to projects such as RUBICODE and the TEEB initiative. In particular he argued that there was an urgent need for research to develop measures of ecosystem services that could be used to monitor policy targets that incorporated the services provided by biodiversity. Following on from Stefan Leiner's contribution, the issue of baselines was also discussed in Myriam Dumortier's contribution, in which she argued that the European 2010 target should be scientifically and coherently translated into local baselines to support the political level in sharing the 'burden of biodiversity conservation' in an equitable way. She emphasized that it was essential for these baselines to be dynamic enough to allow for a changing climate.

Dave Pritchard outlined Ramsar's experience with biodiversity targets. He argued that a key gap in the 2010 target was the fact it was based on a quantitative measure of biodiversity loss and suggested that Ramsar's 'ecological character' concept could offer elements of a way forward on this. He also discussed the challenges in communicating and measuring the "success" of the 2010 target. He called for increased efforts in interpreting the meaning of indicator results and in designing more adapted indicators. He concluded his contribution by arguing that a biodiversity target and indicators regime should be rolled forward in an appropriate way that fosters long-term political continuity on the conservation goal; but with modifications to sharpen the policy-response relevance of the 'stories' told about the meaning of indicator results.

Renat Perelet encouraged discussion on the economic issues inherent in setting biodiversity targets beyond 2010 and highlighted the usefulness of implementing economic incentives in order to encourage people to lessen their impact on ecosystems. Zakir Hossain asked for discussions on targets to be broadened in order to include developing countries, highlighting the impact of EU policies on the rest of the world.

Summary of contributions: Week 2

Discussion continued in the second week on the issue of how the experience of the existing 2010 biodiversity target and its goals, sub-targets and indicators could be used to set updated (or new) relevant, rigorous, balanced and legitimate target(s) and indicator(s) post 2010.

A strong theme was the need to engage society in efforts to conserve biodiversity. Colin Galbraith examined the importance of a collaborative approach when developing a new

target post-2010. In particular he highlighted three key areas to consider: 1) how science is translated into policy; 2) if biodiversity should be assessed on its own or combined with an assessment of the health of ecosystems and the services that these provide to people; 3) the links between the social and natural sciences to ensure that messages are communicated effectively and that people are engaged in maintaining and enhancing biodiversity. Many other contributions highlighted the need for a paradigm shift in the way society viewed its role in conservation. Martin Sharman outlined the ‘wicked problem of biodiversity’ by arguing that biodiversity was inextricably linked to all other activities that we, humanity, have done and are doing to modify this planet and consequently it was not possible to set targets or manage biodiversity by considering it as a separate, somehow untouched, entity. He urged us to re-think our position on earth and to seriously reconsider how we could make our world a sustainable place to live. Equally Adrian Manning called for a change in the way we managed our ecosystems. He argued that biodiversity should be a by-product of how we managed our landscapes sustainably in the future, which would require people ceding some control over ecosystems. In contrast, Jiska van Dijk suggested that it was necessary to consider the problem of biodiversity loss in a more simple way, and that setting a target for biodiversity should focus on biodiversity rather than necessarily trying to integrate other aspects such as ecosystem functioning and ecosystem services.

A key step in achieving a shift in societal attitudes towards biodiversity was to not consider biodiversity conservation as a burden. As such, Jeffrey McNeely argued that maintaining life on earth should be cast in a much more positive light for society to fully engage and contribute in conservation. Similarly Jan Jansen argued that approaches like Natura 2000 should be considered as an opportunity for sustainable economic growth. He did, however, outline the importance of not restricting Natura 2000 with jurisdiction and book keeping, but to adopt a flexible approach in order for it to fulfil its potential as a powerful tool in biodiversity conservation. In addition, using the example of LIFE+ and forest regeneration, he argued that long-term projects needed urgently to be funded. The need for funding to be made more available for large scale and longer term projects was also highlighted by Adrian Manning.

Aðalheiður Jóhannsdóttir outlined the role of law in reaching and maintaining biodiversity targets. She argued that in order to stand any chance of success targets needed to be broken down into sub-targets; be clearly reflected in law; and have a clear legal operationalisation. The need to improve biodiversity governance was raised by many participants this week. Jeffrey McNeely suggested that governments seemed to favour over-exploitation of our natural resources above sustainable use. Similarly, Felix Rauschmayer argued that it was necessary to have a better understanding of the experience with the 2010 target in political circles in order improve upon a new target for the future. Ferdinando Boero argued that rather than focussing exclusively on applied research, decision-makers should support more theoretical research in order to better understand and therefore better conserve biodiversity. He later emphasized the importance of conserving key biodiversity-rich habitats in order to protect the greatest amount of species diversity. Pablo Goicoechea agreed with Ferdinando Boero stating that biodiversity resilience was achieved by conserving the genetic diversity in a given population.

Allan Watt opened discussion on what research was needed to set and monitor biodiversity targets for the future, and the subsequent management of biodiversity. He noted that too much emphasis of the 2010 target had been placed on indicators and that too little research had been carried out on whether or not targets were an effective approach to achieving policy goals. He argued that due to the focus on indicators the role of people in both driving biodiversity loss and in taking action to address it had been ignored. He called for research to be carried out on public attitudes and behaviour in response to communication and implementation of policy, including targets. Felix Rauschmayer outlined a three step approach to creating a new biodiversity target: firstly to define the goal of a new target; secondly to identify the actors the target aims to deal with; thirdly to classify the mechanisms by which to discuss and decide on the target. He argued that considering these three points was more important for the success of a new target than inputting biodiversity sciences into

indicators. Adrian Manning outlined the significance of increasing monitoring efforts in order to follow trends in biodiversity. He also stressed that it was imperative to understand the cause and effect behind these trends in order to be able to manage biodiversity adaptively. Tor-Bjorn Larsson and colleagues summarised the recent outcomes of another electronic conference held by the Swedish Species Information Centre which considered the work that had been carried out over the last decade to halt biodiversity loss. The main outcome of their conference was a proposal for a new political biodiversity target: ‘Safeguarding healthy ecosystems: To ensure that (by 2030) economic and social development is carried out within the boundaries of healthy ecosystems, delivering long term benefits to humankind.’

Summary of contributions: Week 3

Dan Faith argued that it was not the 2010 target that should be abandoned, but our approach to it. He proposed that a 2010 type target could be achieved through implementing systematic conservation planning (SCP) and continued discussion on the need for an integrative approach to a new target, to balance all of society’s needs. This was supported by a number of participants. Ben Delbaere argued that interdisciplinary research was essential in order to make a strong connection between science and policy. Equally, Klement Tockner and Hans-Peter Grossart emphasized the need for tight collaborations between scientists, the public, stakeholders and politicians in order to cope with competing interests and to develop innovative strategies for biodiversity conservation. Diana Hummel encouraged the use of a transdisciplinary approach to biodiversity research based on the social-ecological systems (SES) perspective. Paul Goriup argued that the threat to biodiversity was the result of actions of humanity as a whole and therefore the 2010 target was unrealistic and also impossible to achieve on an individual basis. He followed on from suggestions last week of adopting a more positive approach to halting biodiversity loss by working towards a target of achieving ‘better’ biodiversity and highlighted the need for public support and resources in order to attain this. Similarly Peter Bos called for researchers to take an active role with regard to policy processes in order to improve the relevance and outreach of research projects. Alessandro Gimona highlighted the importance of identifying the barriers to the implementation of policy for land managers and all levels of government.

The importance of engaging society in efforts to conserve biodiversity was further discussed this week. Bernard Kauffmann argued that it was necessary to apportion responsibility of the target and to ensure that this was understood by the electorate to guarantee the successful implementation of measures. He stated that targets needed to engage and implicate the public at a level that was immediately relevant to them. Similarly, Leslie Adams reinforced the importance of engaging the electorate in order to make governments take notice. Zakir Hossain suggested that it was also necessary to free biodiversity from corporate greed and translate all relevant policies, laws and regulations to local dialects. Maria Fonte supported Zakir Hossain’s arguments for engaging local people with the biodiversity target. In particular she raised the issue of conserving agricultural biodiversity due to the dominance of the agro-food industry. Betty Stickers argued that countries had an obligation not to diminish the Farm Animal Genetic Resource and that this required a global approach in order to combine all existing networks regarding conservation of rare and traditional breeds of all categories of animals, plants and agricultural products.

Tristan Tyrrell summarised the outcomes of the CBD and UNEP-WCMC post 2010 indicators workshop listing the recommendations that their participants felt were the most important, namely to:

- Develop a small set of broad headline indicators
- Modify and simplify the current global indicators into four focal areas: threats to biodiversity; state of biodiversity; ecosystem services; policy responses
- Develop a more complete and flexible set of indicators and link actions and biodiversity outcomes to benefits for people
- Further develop national capacity

- Develop a communication strategy
- Maintain a flexible and inclusive approach

Keith Hiscock highlighted that the underlying ecological processes and actions needed to protect marine biodiversity were potentially very different from terrestrial biodiversity needs and that a new target should take this into consideration. Both Ferdinando Boero and Keith Hiscock emphasized the need for the Habitats Directive to be more inclusive of marine research and addressed the need for increased surveying and monitoring of marine habitats. They argued that complete lists of marine habitat types were desperately needed. Ferdinando Boero added that once lists had been made habitats needed to be ranked according to their vulnerability or unicity; the distribution of different habitats needed to be ascertained; and community types and species lists should be associated to each habitat type. He later suggested that in order to preserve a habitat it was necessary to remove its stressors. He also addressed the need to consider the functionality of a habitat in order to ensure that what we had was conducive to proper ecosystem functioning.

Christian Prip opened discussion on the specific conflicts between existing and potential goals, sub-targets and targets and their associated indicators on biodiversity change. He highlighted the need to get biodiversity higher up the political agenda and stated that biodiversity conservation would require different approaches in different parts of the world. Klement Tockner and Hans-Peter Grossart agreed with this approach, arguing that future biodiversity research needed to evaluate the loss of biodiversity at different scales in relation to ecosystem functioning and that criteria needed to be developed to evaluate how this was impacted on by anthropogenic actions. They also highlighted the fact that the 2010 target conflicted with many other targets and directives at national, EU and global scales. In particular they considered the conflict between improving and expanding navigation channels in Europe and reducing the spread of invasive species and biotic homogenisation. Stephan Helfer argued we were dealing with a 'biological uncertainty principle' making it impossible to assess both the position and momentum of biological change. Finally, Klaus Henle re-emphasized the need to research the effects that a post 2010 target may have on biodiversity and on the footprints that strategies to reach this target would have on biodiversity outside Europe. He also highlighted the need to research potential risks to biodiversity as a result of using alternative sources of renewable energy and to develop new strategies that allowed for changes in national and international networks of protected areas due to climate change.

Summary of contributions: Final week

A great deal of discussion ensued in the last week regarding biodiversity and ecosystem services. Renat Perelet suggested that biodiversity was being depleted due to its lack of market value and argued that we needed to highlight the high monetary value of ecosystem goods and services. He went on to suggest a biodiversity protocol based on the Kyoto protocol in order to help conserve and use ecosystem services in a sustainable way. Similarly, Riccardo Simoncini highlighted that the economic value of biodiversity has not been taken into account in land use and policy development so far and consequently that it was now imperative to look more closely at the governance factors and processes that could enhance or impair ecosystem services and biodiversity conservation. Martin Sharman suggested that ecosystem services may help to protect biodiversity from the effects of humanity. He also highlighted that ecosystem services were a powerful tool to persuade those in power of the importance of conserving biodiversity. Equally, Pedro Herrera highlighted the importance of conserving biodiversity in order to ensure the long-term sustainability of ecosystem services. Felix Rauschmayer did however point out that the links between ecosystem goods and services and human well-being were still poorly understood and needed further research. Ferdinando Boero highlighted the anthropocentric nature of ecosystem services and argued that as a society we had focussed too much on the exploitation of ecosystems rather than their conservation. Robert Scholes' contribution very much followed his opinion and served to remind participants that the Millennium Assessment (MA) report used the concept of ecosystem services as a supplement, not a replacement, of the 'intrinsic value' concept of

biodiversity conservation. This was to some extent echoed in Rasmus Ejrnaes' contribution, in which he argued that it was essential to focus research on biodiversity per se rather than restricting research to biodiversity providing human services.

On the topic of conflicts between targets, Francois Bonhomme highlighted the apparent conflict between incentives that drove political decisions, namely growth and wealth, and what should benefit biodiversity. He argued that this called for a major societal change in our way of life and demography and that economic/industrial growth should take account of ecological impacts and minimise negative trade-offs. Denis Ruyschaert also mentioned market oriented economy as one of the reasons contributing to biodiversity loss, together with governance-globalisation, local reality and NGOs' sub-optimal action. He emphasized the importance of influencing world politics in order to get biodiversity higher up the political agenda and the need to improve the link between local, global and multi-level governance. Sandra Luque also supported this idea and argued that an international code of ethics for international companies, such as logging, mining and plantation companies, was urgently needed. Nuria Selva highlighted the need for a post 2010 target to develop methods to overcome potential conflicts between preservation of biodiversity and sustainable development. She also outlined the need to conserve roadless areas in Europe and to research common species as sub-targets/indicators. Pablo Goicoechea supported these views and argued that we should also take the opportunity to learn from the experiences for dealing with climate change. Martin Sharman emphasized that targets should be set in context and that they should be holistic, incorporating the interplay between humans and the non-human components of life on earth. He also argued that future targets would need to recognise that while we need biodiversity, biodiversity does not need us. He suggested that any new targets set should aim to guide our behaviour at a conceptual and practical level.

Participants of the ALTER-Net summer school strongly advocated the need for interdisciplinary research in order to succeed in halting the loss of biodiversity. They highlighted the importance of communicating future targets both in general outreach and to provide practical guidelines for the public to act upon. Sandra Luque also emphasized the need to gain national and international support for monitoring and restoration activities. She argued that long term data collection was needed to develop appropriate conservation and management options and to plan for changes within climate change scenarios. She also supported the need for increased capacity building that could encompass different levels, audiences and contexts, particularly in developing countries. Vladimir Vershinin argued that it was necessary to incorporate both traditional and modern methods in order to gain a better understanding of biodiversity dynamics and management. He highlighted the importance of incorporating all levels of biodiversity in order to help create a more balanced system of biodiversity conservation.

John Hutcheson stated that biodiversity provided the functional flexibility for ecosystems to buffer against environmental extremes. He therefore argued that future research, policy and management should focus on replenishing the current global depletion of buffering capacity. Pablo Goicoechea argued that conservation and restoration efforts need to take into consideration the evolutionary potential of populations and species. He highlighted that genetic diversity was essential in order to preserve the evolutionary potential of a population and to enable them to adapt to environmental changes. He therefore emphasized the need for different populations from the same species to be the subject of conservation efforts.

Sandra Bell outlined a wetlands project that was based on the synthesis of social and natural sciences research. She highlighted that although the final report was commended and the results disseminated through various channels it had very little direct impact. She stated that their research highlighted failures in environmental governance and the implementation of conservation regimes, but that none of the parties responsible for these problems were held to account.



Research priorities

Fiona Grant, Juliette Young, Peter Bridgewater & Allan Watt

1. Target setting

Status and trends

- Improve our knowledge of the diversity and distribution of habitats and species in European waters
- Evaluate and address ecosystem services in each of the relevant policy sectors
- Understand better the links between ecosystem goods and services and human well-being
- Better understand the combined functioning of the social-ecological system

Indicators, monitoring & baselines

- Develop a small set of broad headline indicators
- Develop measures of ecosystem services that can be used to monitor policy targets that incorporate the services provided by biodiversity
- Create a proxy currency to measure the status of EU biodiversity and/or ecosystem services
- Develop indicators incorporating a measure of quality/degradation of ecosystem functioning – not just focussing on quantity of biodiversity
- Develop indicators that consider how efficiently we can balance biodiversity conservation with other needs of society
- Modify and simplify the current global indicators into four focal areas: threats to biodiversity; state of biodiversity; ecosystem services; policy responses
- Better understand the links between biodiversity and their indicators
- Further develop models of overall biodiversity to ensure that they are robust enough to be used in indicators
- Better understand the links between biodiversity indicators and ecosystem goods and services
- Develop better methods for interpreting the meaning of indicator results
- Develop a baseline against which progress can be measured
- Develop local baselines that are dynamic and include functional species groups– what and how much biodiversity is needed at a local level to achieve the European commitment
- Develop a networked monitoring system that allows early detection of negative trends and a sound evaluation of success and failure of any adjustments made to protected sites

Drivers of biodiversity change

- Better understand biodiversity loss at specific, local sites or sectors to improve knowledge on what is happening horizontally (from the ground locally to the international level) and vertically (in time)
- Develop methods to evaluate the loss of biodiversity at different spatial scales in relation

- to ecosystem functioning
- Define relevant criteria to evaluate the impact of anthropogenic actions on biodiversity and ecosystem functioning
- Better understand how changes in biodiversity affect the health of ecosystems
- Improve our knowledge of the stressors acting on European waters

Scenario building, modelling & mapping

- Develop sustainable land-use scenarios in which biodiversity objectives and the socio-economic conditions can enforce each other
- Further develop methods to monitor, at the regional and global scale, biodiversity loss and achievements
- Develop approaches that can use remote sensing to supply time series on change in condition of land and interpret this information using robust global biodiversity models
- Map marine habitats at a European level
- Develop strategies to account for the evolutionary potential of populations and species in conservation and restoration efforts

Policy-relevant priorities

- Update the Habitats Directive to make it more adapted to the marine environment
- Determine the particular planning and conservation instruments that are the most useful for achieving efficiencies in different contexts
- Better understand public attitudes and behaviour in response to the communication and implementation of policy, including targets
- Better understand our role on earth and develop methods to enable society to live sustainably
- Examine how science is translated (or not) into policy

2. Conflicts between targets

- Better understand the impact targets beyond 2010 would have on biodiversity
- Better understand the conflicts between the preservation of biodiversity and sustainable development
- Better understand the conflicts between strategies to protect human health and the preservation of biodiversity and ecosystem function
- Better understand how the strategies to reduce our impact on European diversity affect biodiversity in other regions of the world
- Better understand the benefits and risks of alternative sources of renewable energy for biodiversity
- Further develop strategies to adjust networks of protected areas to climate change ensuring that the reserve systems are flexible
- Better understand if the implementation of policy instruments are coherent with the private/public character of goods to be delivered and understand if they effectively and efficiently contribute to the achievement of the policy goal
- Better understand what the barriers to implementation of policy are for land managers and for all levels of government

3. Governance levels and accountability

Communication and participation

- Develop targets that can be easily understood by the public
- Develop a 'biodiversity budget' that is officially presented to the public at regular dates
- Develop methods to better communicate knowledge from research to those who implement policy on the ground
- Better understand and accept how policy processes and decision making work, in different fields, on different scales and in different types of organisation

Ethics and law

- Develop an international code of ethics for logging, mining and plantation companies, among others
- Further understand how international, national and regional biodiversity law actually functions and whether it is actually working for biodiversity
- Better understand if policy decisions and the management of natural resources are oriented towards the delivery of private or public goods

Factors that need to be considered in order to carry out the research priorities:

Knowledge building and transfer

- Promote collaborative and integrative research
- Provide training for interdisciplinary research
- Build on projects such as RUBICODE and TEEB to shape targets incorporating ecosystem services
- Develop better communication strategies
- Further our theoretical knowledge
- Further research into biodiversity per se as well as biodiversity for human benefits
- Collate information from all hierarchical levels of biodiversity from molecular to the biosphere to create a more balanced system for biodiversity conservation

Political, legal and economic support

- Maintain long-term political continuity on the conservation goal
- Instigate economic incentives to achieve biodiversity goals
- Provide national and international support for monitoring and restoration activities
- Develop new financial mechanisms in order to guarantee continuation of long-term, large scale projects
- Further develop national capacity
- Promote the development of political decisions that are in accordance with biodiversity conservation
- Implement capacity building opportunities that encompass different levels, audiences and contexts, particularly within developing countries
- Develop strategies to help share the 'burden of biodiversity conservation' at the political level in an equitable way, but taking care to avoid habitat homogenisation

Public involvement and support

- Apportion responsibility for targets and ensure that the electorate fully understand
- Engage the global electorate in biodiversity conservation and improve public awareness
- Translate all relevant policies, laws and regulations into understandable local dialects

Changing cultures

- Change our culture and our outlook and spend time to reflect
- Focus should shift from exploitation to conservation

Suggestions for new targets

- Targets need to incorporate a clear legal operationalism
- Incorporate explicitly all other needs of society in any new target
- Determine and acknowledge the impact any EU biodiversity target will have on developing countries
- Develop holistic targets
- Develop a protocol for biodiversity similar to the Kyoto protocol
- Focus on research into biodiversity per se, and less on biodiversity for human services



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Session I: What have we learnt from the 2010 biodiversity target?

Lessons learned from the 2010 target

Stefan Leiner, Nature & Biodiversity Unit, European Commission, Directorate General of the Environment.

This contribution outlines the role of the 2010 target and the importance its presence has in generating political attention to biodiversity. It also highlights some of the key limitations of the 2010 target and suggests ways for future targets to learn from this experience.

NB: These are personal thoughts aimed to fuel the debate and they do not reflect a position of the European Commission.

Recent Communications by the European Commission, such as on the mid-term assessment of the implementation of the Biodiversity Action Plan (BAP), the Composite Report on the Conservation Status of Habitat Types and Species as required under Article 17 of the Habitats Directive, and the report by the European Environment Agency on the state of biodiversity all demonstrate that, despite significant efforts and progress, the EU 2010 biodiversity target will not be achieved. The European Commission is now in the process of developing proposals for a new post-2010 vision and target(s) on biodiversity in the EU to be discussed with the other institutions in 2010. This will form the basis for the development of a new EU biodiversity policy framework. Part of this reflection has to be to analyse and learn from the existing EU 2010 target and strategic framework. This will also support the discussions on a new global target developed under the CBD.

The main value of the 2010 target was in fact the existence of the target itself. It helped enormously in generating political attention and was instrumental in making biodiversity one of the key environmental priorities of the EU. It was a catalyst for the further development of biodiversity policy, as it forced the actors to think about what needs to be done in order to achieve this target and how this needs to be measured. Important projects such as the SEBI 2010 indicators were developed. It also spurred awareness amongst a wide range of stakeholders through initiatives such as IUCN's Countdown 2010. It will be important to maintain and build upon this momentum.

However, the 2010 target has also clearly had a number of limitations which will need to be improved in the future:

1. There was no baseline against which progress could be measured. Whereas the assessments mentioned above indicate that we have reduced the rate of loss in the EU but failed to halt it, we are unable to say how far we are from reaching the target. This also reveals that the target was more of a political 'slogan' than a real SMART target. The absence of baseline has been a major impediment in placing biodiversity on the same footing as climate change in terms of policy priority
2. There has been no unifying 'currency' against which we can measure progress toward the 2010 biodiversity target, in contrast to what is being done using CO₂ emissions or global temperature in Climate Change, GDP and unemployment in economic analysis and the UN Human Development Index. Developing a European biodiversity index as suggested in the 2006 Commission Communication on the Biodiversity Action Plan has so far not been possible and it is indeed a challenge to develop an index which could capture the complexity of biodiversity and ecosystem services. However, there are now some measurable biodiversity indicators around (conservation status assessments, red data lists, common bird index, ...) and some indices (mean species abundance, human appropriation of net primary production, water quality, ...) have been used in ecosystem assessments, which could be used or combined into a proxy currency to measure the status of EU biodiversity and/or ecosystem services. Such an approach would greatly facilitate communication efforts.
3. The current biodiversity target has failed to reflect important emerging issues, in particular the dimension of ecosystem services. This has resulted in a failure to

adequately recognise nature's values and to integrate biodiversity into those sectors that most affect its status. There is little ownership from these other sectors that do not see its relevance. While biodiversity has increased in political importance, it is still too marginal in agriculture, land use planning, economic, finance, trade, development cooperation and even climate change policy. Systems still need to be developed and put in place to ensure that ecosystem services are fully evaluated and addressed in each of the relevant policy sectors.

Conclusion: A new post-2010 biodiversity vision and target should:

- build upon the existing target;
- provide a clear baseline and a concrete 'currency' against which progress can be measured;
- effectively incorporate ecosystem services in order to enhance its relevance to other sectors.

The EPBRS workshop could contribute to the development of this new target by drawing upon the experiences with the existing biodiversity targets as well as targets within other policy areas. The workshop could also indicate where the process of setting and evaluating targets and visions is still being hampered by lack of knowledge, thus pointing out directions for future research.

RE: Lessons learned from the 2010 target

Allan Watt, Centre for Ecology and Hydrology, Edinburgh, UK

Stefan Leiner provides an excellent overview of the 2010 targets, usefully highlighting some limitations, which research may play a role in overcoming.

One of these limitations listed by Stefan Leiner is the lack of a unifying "currency" for biodiversity. I will come back to this in a contribution to another session later in the e-conference, but I would like to make two points now. First, we should avoid currencies that fail to measure important aspects of biodiversity and avoid the use of a single currency for biodiversity – although there is a unifying currency for economics, it clearly did not avert the current financial crisis!

However, unifying currencies may be more achievable for ecosystem services. This is not the only reason for supporting Stefan Leiner's call for the incorporation of ecosystem services in future biodiversity targets, and I would not suggest that the sole emphasis be placed on a unifying currency of monetary value. Nevertheless, large numbers of species and ecosystems contribute to a smaller number of ecosystem services, these services often have biophysical attributes, some services can be measured in monetary terms and many services contribute to human well-being.

Research is therefore urgently needed to develop measures of ecosystem services that can be used to monitor policy targets that incorporate the services provided by biodiversity.

Projects such as RUBICODE (<http://www.rubicode.net/>) and the ongoing TEEB initiative will contribute to this research need and should play a key role in shaping targets incorporating ecosystem services but much more research will be needed in the future to support the monitoring of the full range of ecosystem services.

RE: Lessons learned from the 2010 target **Marine versus terrestrial biodiversity**

Ferdinando Boero, University of Salento, Italy

The outline provided by Stefan Leiner is full of statements of failure. I think that there are, however, many good things that can be accounted for by the EU initiatives towards the knowledge, protection and management of biodiversity.

My impressions are:

The Habitat Directive recognizes habitats as the pivotal concept defining the state of biodiversity. This is a strategic decision that solves the problem of the knowledge of species. It is tenuous to protect the species (since their distribution and even existence are mostly unknown) whereas it is much easier to identify habitats. Protecting and managing habitats has the result of protecting the species inhabiting them.

In principle, we might solve the problem rightly raised by Stefan, of posing baselines by stating that, given a habitat type occurring at several places, the best conditions are found where biodiversity (in this case species diversity) is higher. In this way, we can pass from habitats to species.

A priority should be, at this stage, to update the Habitat Directive so to make it more marine, and then to launch an initiative for the mapping of marine habitats at a European level, especially along the coasts, where the mosaic of habitats is very complex and where our impacts are stronger. This would give some justice to the disparity in treatment of marine verses terrestrial habitats.

Ramsar's experience with biodiversity targets

Dave Pritchard, Scientific & Technical Review Panel (STRP) of the Ramsar Convention on Wetlands, UK

The Ramsar Convention has adopted a set of indicators for assessing the effectiveness of aspects of the Convention's implementation; and these are supporting assessments of progress towards the 2010 target.¹ Experience from this includes:

- The institutional infrastructure mobilised around the target has been useful in building convergent mandates and consensus messages across a range of stakeholders.
- Ramsar has found that qualitative information can be extremely valuable and cost-effective as a basis for indicators.
- There is a trade-off between simple measures that serve a public advocacy purpose and others that are able to help with fine-tuned adaptive decision-making. Indexing or aggregating measures sometimes makes the story simpler and sometimes more complicated.
- Ramsar found it unhelpful to try to classify indicators according to DPSIR or similar frameworks.
- Attributing causes to observed effects relies on a range of assumptions which need to be stated and are often not proven; so deductions about drivers and responses are often weakly-based; and future systems need to be honest about this.
- A key gap in the 2010 regime concerns the quality/degradation of ecosystem functioning (and consequences for delivery of ecosystem services), since the target, based on biodiversity loss, is about quantity, not quality. Ramsar's 'ecological character' concept may offer elements of a way forward on this, as would measures of ecosystem resilience and 'imminence of collapse'.
- The construction of the target has caused communication difficulties, since it is not about negative versus positive trends, but a change in the rate of decline. It is critical to be clear that a 'success' in terms of reducing the rate of decline (which may appear as an 'improving trend'), will still relate to a continuing absolute loss of biodiversity, unless the trend has improved to the extent of passing the point where it switches from negative to positive. 'Storylines' will need to be very clear about what constitutes 'good news' or 'bad news' in this context.
- Whatever the target, significant efforts need to be allocated to interpreting the meaning of indicator results. At the same time, indicators should be designed as far as possible to 'communicate themselves', by having 'intuitive immediacy'.
- We expect to show that a constant or worsening rate of biodiversity decline is occurring even in some cases where diligent implementation of agreed actions is being undertaken by governments. This does not necessarily mean that the action was misguided or a waste of effort, since the question may be how much worse the situation would have been without it. In general, baselines, control situations and hypotheses are all relatively weak areas of indicators in this field. In most cases, all that it is possible to do is to compare 'with action' and 'without action' outcomes in different places as a surrogate for changes over time; or to compare 'before action' and 'after action' outcomes in the same place but without being able to keep other variables constant. These are important challenges for future analyses.

Conclusion: A biodiversity target and indicators regime should be rolled forward in an appropriate way that fosters long-term political continuity on the conservation goal; but with modifications to sharpen the policy-response relevance of the 'stories' told about the meaning of indicator results.

¹ International Expert Workshop on the 2010 Biodiversity Indicators and Post-2010 Indicator Development Lessons from the regional use of biodiversity indicators: the SEBI 2010 project <http://www.cbd.int/doc/meetings/ind/emind-02/official/emind-02-08c-region-en.pdf>

Economic issues

Renat Perelet, Moscow, Russia

It is important not to forget the subject of economic issues in mapping out biodiversity targets beyond 2010.

For example, to keep baby seals from extinction V.S. Putin's recent decree on imposing a ban on hunting them included an allocation of 50 million Russian Ruble (about 3.6 million US dollars) to Russian indigenous people in the area. This approach may not be universally applicable but various (which?) economic instruments (especially incentives, since bans are often ineffective) should be explored to be used in the years ahead in different areas of the world to conserve biodiversity. Human beings should be given incentives to intervene in nature as little as possible.

The (human) ecosystem approach to managing biodiversity is possible, but how humans can be taken into account in it is not often clear.

Re: Economic issues

Jeffrey McNeely, IUCN, Switzerland

While I agree that biodiversity conservation should be everybody's business, I do not think that it is helpful to consider this a "burden". Rather, it is a responsibility, and for many of us, a pleasure. To cast this in terms of a heavy burden makes it far less attractive, as if it is some sort of unpleasant task. Maintaining life on earth should be seen not as a burden, but cast in much more positive terms if we are actually to convince all sectors to contribute.

I strongly agree with Renat Perelet about the importance of economic issues and the report of the project on the Economics of Ecosystems and Biodiversity (TEEB) will surely be able to help inform the post-2010 target. And note that the 2010 target was adopted by all 191 Parties of the CBD, so it is definitely not confined to the EU. On the other hand, the EU has been particularly energetic in seeking to assess progress toward the 2010 target, with indicators being tracked at the country level and reported by the European Environment Agency.

RE: Economic issues

Apportioning responsibilities before defining targets?

Bernard Kaufmann, University Claude Bernard - Lyon 1, France

While defining global and pan-European biodiversity targets (or indicators) is a worthwhile, if risky, endeavour, what in my mind renders any implementation of any target difficult is the apportionment of responsibilities. If responsibility apportionment is not sorted before even setting targets, I think no policy can ever be met with success.

To make it brief:

- Who is responsible for setting targets, implementing measures to reach these targets and evaluating the success of implementation? We need a consensus between scientists, naturalists, NGO's, administrations, politicians, the tourist and agricultural industries etc.
- At which geographical/political scale should targets be set/implemented/evaluated; at a European/national/regional/sub-regional level?
- Before whom should responsibility be met; administration, government, legislature, electorates?

The last point is for me the most important. In the end, in countries of the EU, the ultimate judge is the electorate. If the electorate cannot comprehend the apportionment of responsibilities, implementation of measures will fail. If the electorate cannot understand the

targets, implementation of measures will fail because failure would not lead to any penalty to those responsible.

This means that at least some targets should be easily understood by the general public. It also means that the public should be implicated by the targets and that targets correspond to something the public can experience at their own scale of understanding and concern.

For example, if targets are European, if responsibilities lie with each state, if implementation is evaluated at the European level but never subjected to direct or indirect democratic control, as is the case now, it is no surprise that they fail.

However, for example:

- If targets were European, but set at regional levels (e.g. German Länder, French regions) by consensus (between actors and regional, national, European representations) and agreed by regional parliaments or council
- If the regional administration was responsible for applying measures
- If evaluation was independent (national or European for example, but environmental auditing could be conducted by the academic sector, by commissions including scientists, NGOs, lobbies, administration and politics, or by private sector auditors)
- If annual progress was put before regional councils, then things would be clearer for the public, and hence more likely to succeed.

The closest analogy to what I mean here is national budget. Each year, legislative assemblies' debate state income and expenses, and the media report a measure of how well the state is conducted, budget-wise.

A "biodiversity-budget" - targets for the year (or longer periods, but not too long!), plus results from the preceding term - officially presented to the public at regular dates, might be one solution.

We have now come full-circle back to the definition of targets. Because of the chain and apportionment of responsibilities, targets have to be as seemingly simple (to the public at least) as the +/- of the state budget.

For example, habitat loss (including a measure of fragmentation) is one of the easiest targets to monitor and most intuitive for the public - it is a +/- in square km. It is also easily placed on maps at a variety of scales, as are economical or demographical indicators.

RE: Economic issues

Apportioning responsibilities before defining targets?

Leslie Adams, Canada

In the north, I believe we have moved on from considering biodiversity as something that we are dependent on (including function), and instead embrace that we are a part of biodiversity. This needs to be one of the elements that is underscored to both civil society and governments.

There is also little awareness that there even is a target in the north. Without the awareness, people do not embrace the ideology. There is something powerful in knowing that citizens around the world are engaging in a common goal and that we all have a part to play. Once the global electorate engages, governments take notice.

Linking EU biodiversity policy with developing countries

Zakir Hossain, Barisal, Bangladesh

Any EU policy has quite an impact on developing countries. Acting as the single large development partner, EU biodiversity conservation target will certainly affect the biodiversity of a developing country like Bangladesh.

It is therefore very important for this discussion to extend beyond the political territory of only the EU.

RE: Linking EU biodiversity policy with developing countries

John Ceasar, University of Guyana

I agree Zakir Hossain. At the end of it all we have become increasingly interdependent in a global village. Climate change lessons affect all of us. I believe biodiversity loss may soon be recognized as a global human security issue that will affect both developing countries and the EU in ways we are yet to fully comprehend. The case of invasive species may be the glimpse of this. Disease pandemics caused by “pathodiversity” is a good signal of the potential risks. The EU should continue to build capacity in these areas in developing countries for our common global good. I endorse Renat Perelet’s proposal for a global Biodiversity compact along the lines of the Kyoto/Copenhagen Protocol. We have to be each other’s keeper for the health and security of our biodiversity and the ecosystems.

The baseline dilemma

Myriam Dumortier, INBO, Belgium

N.B. These are personal thoughts to fuel the debate and they do not reflect a position of the INBO.

In Flanders², freshwater quality, as well as fish, dragonfly and water bird populations are slowly recovering. Can we congratulate ourselves for the achievement of the 2010-target for freshwater ecosystems in Flanders? The majority of the our rivers are in a moderate to poor ecological status, and even with increased efforts the objectives of the European Water Framework Directive will never be achieved in time. In other regions, still possessing a large number of rivers with good ecological status, freshwater quality and biodiversity is still decreasing. These regions did not achieve the target... Judging the trend of biodiversity loss without considering the status is an unfair approach, particularly towards less developed countries. Not the trend, but the status needs to be evaluated.

The 2010-target is a very valuable commitment at a global level. It should be maintained after 2010, with the extra commitment to restore all biodiversity loss after 2010 at the European level. When scaling down this commitment to states and regions the European 2010-target should be scientifically and coherently translated into local baselines. What and how much biodiversity is needed at the local level to achieve the European commitment? For aquatic ecosystems in the EU, the European Water Framework Directive requires a good ecological status in all surface waters by 2015; this is still far ahead. Similarly for terrestrial ecosystems the ‘good ecological status’ needs to be defined. The Birds and particularly the Habitats Directive, requiring a good conservation status of selected species and habitats, are a step in the right direction. However, in particular their species approach is far from representative for biodiversity. The local baselines should involve a variety of functional species groups. They should moreover be dynamic in order to cope with the changing climate. This is an important issue for future biodiversity research.

Moreover, the scientific community should deliver different strategies to help the political level in sharing the “burden of biodiversity conservation” in an equitable way. The long term consequences of alternative strategies can be assessed through scenario analyses. When sharing the “burden of biodiversity conservation” in an equitable way, the phantom of homogenization should be considered. Restoring biodiversity in Flanders will hardly compensate the further loss of biodiversity in less developed countries. The balance could lead to an equally moderate quality all over Europe. Financial instruments could be launched to transfer biodiversity responsibilities among countries and avoid homogenization.

² The Flemish assessment of the 2010-target is available at <http://www.inbo.be/docupload/3997.pdf>.

Are LIFE+ actions without research successful in native forest regeneration projects?

Jan Jansen, Radboud University Nijmegen

Restoration of Natura 2000 forest habitats on former grazing areas is needed in many parts of Europe. LIFE+ contributes to the EU's goal of halting the loss of biodiversity, financing concrete actions but not or hardly research actions. This makes the financial basis for the regeneration of native forest ecosystems on former grazing areas very complex and almost impossible to realize. It is suggested to take research on board within LIFE+ regulations at least when forest regeneration on former grazing areas is concerned.

LIFE+ Nature and Biodiversity supports projects that contribute to the implementation of the EU's Birds and Habitats Directives, and that contribute to the EU's goal of halting the loss of biodiversity. LIFE+ finances concrete actions but few if any research actions. This makes the financial basis for the regeneration of native forest ecosystems on former grazing areas very complex and almost impossible to realize.

Since the Neolithic revolution biodiversity has become more and more dependent on agro-pastoral systems. In most places virgin forests disappeared and were replaced by extensive outfields, also called waste lands. By the end of the 19th century when these systems gradually declined, other land-use systems evolved such as forestry and modern agriculture, which both have usually a (very) negative effect on biodiversity due to the planting of non-native trees and pollution by intensive farming. Over 60% of farmland in the EU is located in so-called Less Favoured Areas (LFAs) and it is in these areas that a major part of the Natura 2000 network is allocated. Now Natura 2000 provides the political-administrative framework in which LIFE+ can become a vehicle to regenerate native forests as the State Forestry was for the planting of productive woodland species on heathlands a century before.

One of the major questions is how to go from a declining traditional grazing system towards a complex self-sustaining forest ecosystem and how to integrate a natural forest in the mosaic of open Natura 2000 habitats in the agro-pastoral landscape under present fire risks and expected climatic change. But before addressing that question, another question should be answered namely whether it is possible to convert shrublands into native forests again.

In general it is thought that planting native trees can be the solution. But is an area with merely planted native trees a truly native forest ecosystem?

To make a forest ecosystem 'work', two major processes should be restored: 1) nutrients from plants should be made available to the food chain by herbivores; 2) dead plant material should be mineralized and recycled. Key questions are: 1) how nutrients from trees are passed on to higher food chain levels (herbivore community); 2) what soil biota facilitate the mineralization of dead plant material and plant nutrient uptake (decomposer community and mycorrhizae). More questions need to be answered and therefore regeneration of native forests needs to be accompanied by research. However within LIFE+ there is no such possibility.

So if one really wants to restore complex native forest ecosystems that are really capable of self-rejuvenating, other funds need to be searched for, such as FP7. This makes a project highly complex and the chance that both applications - one part with concrete actions for LIFE+ and the other with research for FP7- would become approved is very small.

My point is that at least in these cases when addressing the process of native forest regeneration research should be granted by LIFE+ in order to have any chance to become successful, halting the loss of biodiversity related to native forests. In addition forest regeneration is a time consuming process while LIFE+ only grants a period of 5 years. New financial mechanisms need to be developed in order to guarantee the continuation of such projects.

What can we learn from the 2010 target?

Colin Galbraith, Scottish Natural Heritage, UK

This contribution examines the importance of a collaborative approach when developing a new target post-2010.

The EU 2010 target of halting biodiversity loss has focussed minds on the natural world in a way not seen for some time. Perhaps only the publication of the Millennium Ecosystem Assessment has achieved a similar level of interest over recent years. There has, however, been a rather belated look at exactly how the target will be measured, and from this how it will be judged to have been met or otherwise. Measuring is clearly important and issues such as extinction, contraction of species range or reduction in the extent of habitat are of key interest. More subtle changes such as a lessening of habitat connectivity or a reduction in breeding success in species all play their part in changing our experience of the natural world, yet these factors may not be captured in a diverse assessment of biodiversity “loss” per se. So what can we learn from how the target has been portrayed?

Simplistically, there have been three stages in the derivation and use of the target. Firstly, the intense discussions about the detail of wording, secondly the detail of how the target might be measured, and thirdly, although almost completely lacking so far, discussion about what to do about the ecological problems being revealed as part of the assessment processes leading towards 2010. Whilst these underlying problems are extremely complex and difficult to resolve, and the measurement of ecological change always open to variable interpretations, the key point is that the messages that we give to government and to others from any such assessment has to be simple, reliable and based on a collective view of the underlying science. Simply to give the underlying science, without the value of collective judgement, is much less valuable.

The Millennium Ecosystem Assessment used the expertise of over thirteen hundred scientists from around the world and condensed their views into a set of very clear reports and, importantly into simple diagrams and figures that represented collective judgement. It also made the clear link between people and the world around them, i.e. how our survival depends on the health of ecosystems. Importantly it also demonstrated the impact that we are having on these ‘life support systems’.

So what does all this mean for a new target post-2010? Firstly, it is perhaps timely to examine how we translate science into policy, to try to simplify the message and to give one coherent view about the changes being seen. This may take the development of a new collective assessment process at the international level. Secondly, should we be considering a target that encompasses an assessment of the state of biodiversity only or should it include also an assessment of the health of ecosystems and of the services these provide to people? The latter would make the link between global biodiversity and the life experiences of people around the world. Thirdly, we need to re-examine the interplay between the social and natural science to help ensure that messages are communicated effectively and that people are really engaged in maintaining and enhancing their world. Taken together these three areas of activity would perhaps help ensure the delivery of positive change, in addition to helping the development of a new target per se.

The role of law in reaching and maintaining biodiversity targets

Aðalheiður Jóhannsdóttir, University of Iceland, Reykjavik, Iceland

Sufficient legal operationalisation³; law's substance and a systemic view of law play a fundamental role in reaching and maintaining biodiversity targets at all levels of governance.

There seems to exist a general consensus on the issue that the 2010 biodiversity target, or to effectively reduce biodiversity losses and to achieve by that year a significant reduction of the current rate, and even to stop and reverse the current losses at all levels by 2010 (see note 1), has not materialised itself sufficiently in nature. The reasons for this failure are undoubtedly several. One is a failure that relates to law; sufficient legal operationalisation of targets and how law actually functions as a system(s).

The legal instruments and the legal methods that have hitherto been used to reflect the 2010 target need attention. What they have in common is that they fall within a category that is usually referred to as soft law. Although soft law's importance should not be minimised in any way, it is, as the words themselves reflect, the opposite of hard law (Jóhannsdóttir, 2009a). A reference to the 2010 target, or any other concrete biodiversity target for that matter, is not visible in the substantive provisions of any of the treaties that can be labelled as international biodiversity law (see note 2), or do the relevant EC directives (see note 3) hold such clear cut targets in their operative texts (see note 4)?

Having in mind the multi-levelled (international, regional and national) governance, that includes several multi-layered legal orders (Jóhannsdóttir, 2009b), and how law actually works as a system, allows the structure of individual provisions of a treaty to be made more accurately⁴; and therefore the more likely it is that law (any law at any level) will actually influence the actions of all relevant actors (Westerlund, 2003a; Jóhannsdóttir 2009c). The reason relates to how law actually functions as a system (any legal system), how it influences the respective and relevant actors, including public authorities and enforcement bodies, and finally the rule of law (Jóhannsdóttir, 2009c).

From a legal point of view, global targets seem an appropriate method. However, they need to be broken down into sub-targets and they must also be clearly reflected in law in order to diminish the ruling character of some of the fundamental principles of any legal system, finally targets need a clear legal operationalisation (Jóhannsdóttir, 2009d).

The weakness of the existing global target is not its content or aim, but rather lack of sufficient legal operationalisation and the instruments which have been chosen to reflect it. Thus, the operative text of the respective legislation must contain the target as well as its principle sub-targets (Jóhannsdóttir, 2009d; Westerlund, 2003b).

Further research on international, regional and national biodiversity law is a fundamental issue. All such research should focus on how law actually functions and whether it is actually working for biodiversity. Furthermore, it should strive to draw forward legal barriers or obstacles for an effective implementation and enforcement of biodiversity law. The fundamental principles and models of environmental law methodology should be used for this purpose and a systemic approach is paramount (see note 5).

Note 1: Cf. inter alia: CBD COP Decision VI/26 Strategic Plan for the Convention on Biological Diversity (2002); the Hague Ministerial Declaration (2002); CBD COP Decision VI/28 (2002) Multi-year programme of work of the Conference of the Parties up to 2010; CBD COP Decision VII/30 (2004) Strategic Plan: further evaluation of process; CBD COP Decision VIII/15 (2006) Framework for monitoring implementation of the achievement of the 2010 target and integration of targets into the thematic programmes of work; CBD COP

³ Operationalization is the process of defining a fuzzy concept so as to make the concept measurable in form of variables consisting of specific observations. In a wider sense it refers to the process of specifying the extension of a concept.

⁴ In principle, the same applies to the structure of EC directives and national legislation.

Decision IX/((2008) Review of implementation of goals 2 and 3 of the Strategic Plan, and CBD COP Decision IX/9 (2008) Process for the revision of the Strategic Plan. See also one of the Millennium Goals, Goal 7, on ensuring environmental sustainability and the Millennium Development Goals Report 2007, p. 30. See furthermore: Decision 1600/2002/EC of the European Parliament and of the Council of 22 July 2002 laying down the Sixth Community Environment Action Programme: Our future, our choice, OJ L 242, 10.9.2002, pp. 1-15, and Communication from the Commission Halting the Loss of Biodiversity by 2010 – and beyond sustaining ecosystem services for human well-being, COM(2006)216 final.

Note 2: See further: Convention on Wetlands of International Importance Especially as Waterfowl Habitat (1971) (Ramsar Convention), 11 ILM 963 (1972); Convention on the Conservation of Migratory Species of Wild Animals (1979) (Bonn Convention), 19 ILM 15 (1980); United Nations Convention on the Law of the Sea (1982) (UNCLOS), 21 ILM 1261 (1982); Convention on Biological Diversity (1992) (CBD), 31 ILM 8181 (1992), and Agreement for the Implementation of the Provisions of the United Nations Convention of the Law of the Sea of 10 December 1982, Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (1995) (Straddling Fish Stocks Agreement), 34 ILM 1542 (1995). See on the other hand a fundamentally different approach in Article 3(1) of Protocol to the United Nations Framework Convention on Climate Change (1997) (Kyoto Protocol), 37 ILM 22 (1998), stipulating a legally binding numerical objective: “... reduction commitments ... with a view to reducing ... overall emissions ... by at least 5 per cent below 1990 levels in the commitment period 2008 to 2012.”

Note 3: Cf. Directive 79/409/EEC on the conservation of wild birds, OJ L 103, 25.4.1979, p. 1; Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora, OJ L 206, 22.7.1992, p. 7, and Directive 2004/35/EC on environmental liability with regard to the prevention and remedying of environmental damage, OJ L 143, 30.4.2004, p. 56.

Note 4: See, on the other hand, Articles 2(2) and 6(1) in Decision 1600/2002/EC of the European Parliament and of the Council of 22 July 2002 laying down the Sixth Community Environment Action Programme: Our future, our choice, OJ L 242, 10.9.2002, pp. 1-15, and Communication from the Commission Halting the Loss of Biodiversity by 2010 – and beyond sustaining ecosystem services for human well-being, COM(2006)216 final.

Note 5: See further on environmental law methodology: S. Westerlund: Environmental issues are fundamentally linked 2.0. IMIR Institute of environmental law. Åmyra publishers, Björklinge, 2003.

Some thoughts from the first week

Peter Bridgewater, E-conference chair, JNCC, UK

I am very appreciative of the rich range of ideas and thoughts coming forward – but I still would like to see some more discussion on the research needs to clarify some of the issues – here is my take on the first full week of postings, to try and stimulate responses to that issue.

Targets which include people and their activities appear to be bubbling up through the discussions, including economic and legal issues. How much research is needed in this trans-disciplinary area? In particular, building on Colin Galbraith's thoughts: what research is needed at the science policy interface?

Then there is the concept of biodiversity currency raised by Stefan Leiner and Alan Watt, among others - If we involve economic arguments and measures, what is the research baseline for that? And yes everything is ecosystem services now, but what is the relationship between biodiversity and ecosystem services and what research orientations do we need to tease this relationship out?

Ramsar, as Dave Pritchard notes, uses an ecological character concept – looking for change in this is the internationally important site. Yet such a concept has its own weakness, since “change happens”, as one insurance company has in its advertisements! How can we tease out anthropogenic change for ongoing ecological processes – and should we assume anthropogenic change is not part of on-going ecological processes anyway? This links into comments by Jan Jansen on research on restoration – is simple restoration enough? Does the ecosystem that is restored offer a sustainable future/ is it resilient?

Homogenisation is also important – are we moving to an increasing homogeneous world? If so, is that a bad thing? What research needs are there to help analyse this situation? How can we deal with the multi-scalar, multifunctional approach that biodiversity demands? For example, the status and trends of biodiversity globally doesn't make sense in the way CO2 levels do, what happens in my woodland next door is very relevant and measurable... Although of course funding of research that is long-term enough to make sense of all this remains difficult.

And finally, what about biodiversity footprints of the EU and member states? We may, as Myriam Dumortier suggests, restore systems locally – but at what cost further afield, especially in far away countries, often developing ones?

RE: Some thoughts from the first week ICZM and the ecosystem approach

Ferdinando Boero, University of Salento, Italy

Answering Peter's questions we might recall some concepts that are being enforced, at least formally, throughout the EU.

The Ecosystem Approach stems from the awareness that it is meaningless to consider human activities without putting them into context with regards to the ecosystem they interact with and impact on. Man is part of nature. This has to be explained to economists, who ask for infinite (economic) growth in a finite system (our planet) and who externalize ecological impacts from their balances. The disasters we are facing are simply due to this myopic and human-centred attitude (the economists rule the world, not the scientists). Integrated Coastal Zone Management (ICZM) is another way to say the same thing. We must integrate all our knowledge (both basic and applied) to protect and manage coastal systems (I would say all systems) in a wise way. There are no shortcuts.

If, with models, we transform complex systems into simple systems (avoid considering relevant variables and interactions) we have an oxymoron: simple models of complex systems, treated as if they were simple (the systems, not the models, these are very complex indeed, but not enough). The quest for “integration” and the “ecosystem approach” means

that we have to shift from the simplicity of the past (with precise forecasts that have mostly failed and that have led us to economic and ecological disaster) to the real complexity of the systems, with less precise predictions.

This is well explained by Darwin who, in the *Origin of Species*, said:

“Throw up a handful of feathers, and all must fall to the ground according to definite laws. But how simple is this problem compared to the action and reaction of the innumerable plants and animals which have determined, in the course of centuries, the proportional numbers and kinds of trees now growing....”

We treated complex (historical) systems as if they obeyed exclusively the definite (a-historical) laws that govern the handful of feathers thrown in the air by Darwin (and so well understood by Newton). But this is too simple a problem, in spite of the complexity of the mathematics expressing it.

So we need to change the culture we use to approach complex systems. Let us celebrate Darwin’s bicentennial by understanding his message. Maybe the handful of feathers message is now his more important one. Once we understand that, we must single out all the relevant variables and interactions that make up our systems and try to build scenarios out of them. The separation of disciplines is not conducive to this exercise, since all reductionist approaches are convinced to be sufficient to solve all problems. Sorry folks, they are not. We cannot continue like that. We have to transform the buzzwords of ICZM and the ecosystem approach into good practices. Not just continue doing the same old things with a new label.

The last century was the century of reductionism. Now we must change our attitude and enter the millennium of integration, avoiding the infantile expectation that all systems are reducible to mathematical relationships that can be explained with an equation, as Darwin explained so well. Once this is understood, and we are crashing against its evidence, we have to restart designing our relationship with the environment; giving substance to the buzzwords. This cultural gap has to be filled, and we are very far from that.

All governments, and also the EU, call for applied research. Very little is done in the basic fields. This is a strategic mistake. We need to build a new philosophy, and this calls for more theoretical research (not with mathematical models, please, they have made enough mess already), to build a different framework from the current ones.

RE: Some thoughts from the first week

Jeffrey McNeely, IUCN, Switzerland

It is worth keeping in mind, when reviewing the 2010 biodiversity target, that the targets of the Kyoto Protocol, which were supported by considerable funding and solid science, have also fallen woefully short. Perhaps worse, the Kyoto Protocol targets were very modest in relation to the needs for reductions in emissions of greenhouse gases (a case which has been made increasingly stronger in the years subsequent to the adoption of the Kyoto Protocol). The climate change research, as embodied by the reports of the Intergovernmental Panel on Climate Change (IPCC) is far stronger and better targeted than the research on biodiversity; yet even this strong research foundation was unable to ensure that the targets were met, suggesting that significant conflicts remain between different policy goals of governments. This background may help to illuminate our discussion on the new biodiversity targets (or framework).

As a general response to the three questions posed by Peter in his second paragraph, the target is poorly formulated (assuming, for example, that reducing the current rate of biodiversity loss at global, regional and national levels will contribute to poverty alleviation, an assumption that is perhaps best regarded as a hypothesis that is likely to show considerable variability at different geographical scales). But in any case, policy goals of governments seem to favour over-exploitation above sustainable use, judging from observable behaviour and research findings of the Millennium Ecosystem Assessment. The combination of the poor formulation of the target and the conflicts between different policy goals results in the observed poor governance of biodiversity at national, regional and global levels.

RE: Some thoughts from the first week

Pablo Goicoechea, Spain

To (partially) answer Peter Bridgewater's question about resilience:

Most of us will probably agree that, among other things (such as trophic chains etc), resilience is linked to high levels of genetic diversity, but even though this is an intuitive concept definitive examples are not at hand (should it be a research priority to find such examples?).

Maintaining the genetic diversity of any population will depend on the number of effective reproductive individuals (N_e). For some time now, this magic number has been circulating, at least among forest geneticists, and there is an agreement it should be close to 500. There are a few more doubts about the total number of individuals in the population (N) necessary to reach such an effective number. Some estimates have been made that $N=N_e*10$; although this equality can be more appropriate for forest trees than for other organisms (another research priority?).

Paraphrasing Ferdinando Boero, given a habitat type occurring at several places, with similar species diversities, the best conditions are found where genetic diversity is highest (and has better opportunities to remain in time). Interestingly, this poses a challenge to Martin Sharman's comparison between art and diversity. It seems we can tell which diversity is best. In fact, if we know Michel-Angelo instead of some of his contemporary colleagues it is probably only because somebody valued his art best.

RE: Some thoughts from the first week

Klaus Henle, UFZ, Germany

Summary: I argue that one research priority in relation to the summary provided by Peter Bridgewater is research on the effects other targets beyond 2010 (e.g. for biofuel and more broadly renewable energy; CO₂ targets) have on biodiversity and the footprints strategies to reach these targets have on biodiversity outside Europe. Also the elevated chances and risks for biodiversity by alternative sources of renewable energy is a high research priority. Finally, we need strategies that allow adjustment of national and international networks of protected areas to climate change.

Peter Bridgewater's summary raises many important research issues. I would like to combine two issues into research suggestions. At the European level and globally we have not only biodiversity targets, but we additionally have other environmental targets such as for the use of biofuel or for the limitation of climate relevant gases into the atmosphere. In these fields various mitigation and adaptation strategies are developed. Some may provide synergism with biodiversity conservation strategies but others may cause negative impacts on biodiversity. While considering mitigation strategies, or for example biofuel, we should take a global perspective. Which demands are created by the EU and international policies, how do they impact on biodiversity, and how do strategies to reduce their impact on European biodiversity affect biodiversity in other regions of the world? We still know far too little about these global relationships.

Additionally, from an initial hype on biofuel we have moved to a - on average - very critical position. What are the relative benefits and risks of alternative sources of renewable energy for biodiversity? We need energy and we tend to assess and discuss alternatives in isolation of other alternatives. Such a comparative evaluation would be of very great importance to direct future energy policies and to reduce negative biodiversity effects.

The question of how to adjust networks of protected areas to climate change is an important issue that is increasingly addressed. While we have tools available that allow us to develop recommendations from a natural science perspective (primarily climate envelope modelling), we have insufficient knowledge of how such adjustments could be made in the

real world. A key issue here is how we can make reserve systems flexible without jeopardizing what has been achieved. One prerequisite would be a sufficiently strong legal/governance system that ensures that any adjustment does not fall behind what has been previously achieved, e.g. removal but not addition of sites. It would also need a reference framework agreed among states and stakeholders that allows evaluation whether any suggestion for adjustment improves the system, e.g. by improving complementarity and coverage or viability of target species and habitats. It would also require a networked monitoring system that allows early detection of negative trends and a sound evaluation of the successes and failures of any adjustments made to the system of protected sites. All of these are key research questions to move beyond the 2010 target.



Session II: Research needed to set and monitor future targets.

Do we know if targets make a difference to attitudes and behaviour that affect biodiversity?

Allan Watt, Centre for Ecology and Hydrology, Edinburgh, UK

The topic of this session is a complex one, covering three linked areas: a) research to set biodiversity targets, b) research to monitor these targets and c) research to monitor the management of biodiversity.

Regarding the first area – research to set biodiversity targets – time is very short. Either policy makers need to proceed without further research or the research will have to be done rapidly enough to inform the policy process over the next few months. The latter option is, of course, ridiculous: there is no time left for further research to inform policy on setting biodiversity targets. It is nevertheless worth considering what that research might include because any targets set in 2010 (assuming, of course, that policy will include a new target or targets) should be regularly reviewed.

Looking at the research done since the 2010 target was set, it is striking how much attention has been placed on indicators, and how little research has been done on whether or not targets are an effective approach to achieving policy goals.

Perhaps we do not need to ask whether the 2010 targets has promoted action on conserving biodiversity because there clearly has been an enormous effort placed on slowing or halting biodiversity loss over the last decade. But perhaps we should be asking whether the targets resulted in more effective action than would have taken place without these targets in place, whether the global target to significantly reduce the loss of biodiversity was more or less effective than the European target to halt the loss of biodiversity, how were these targets applied to specific habitats and species and did this affect existing efforts on them?

The focus on indicators inevitably means that the role of people not only in driving biodiversity loss but also in taking action to address it tends to be ignored. The way the issue of biodiversity loss is communicated and the manner in which policies to address it are implemented are crucially important to the success of any policy. Research on public attitudes and behaviour in response to communication and implementation of policy, including targets, is therefore needed. It should address both the broader public, whose actions may or may not be influenced by targets, and those more directly engaged in activities that affect the conservation of species and habitats, many of whom are more likely to be more knowledgeable than those that set broad policy goals. Such research would not influence the setting of policy, including targets, for the period immediately after 2010 but could play an important role thereafter.

The wicked problem of biodiversity

Martin Sharman, European Commission, Brussels, Belgium

This contribution urges the reader to re-think our position on earth and to seriously consider how we can make our world a sustainable place to live.

N.B. The views expressed in this comment are purely my own and may not in any circumstances be regarded as a position of the European Commission.

‘What research do we need to set and monitor biodiversity targets for the future, and the subsequent management of biodiversity?’ The question assumes that targets are the right way to go. I’m not so sure that’s true. And it also assumes we can fix what’s wrong by managing biodiversity. I’m dead certain that’s wrong. Why, for this issue of biodiversity loss, do targets trouble me and management muddle me? It’s not easy for me to formulate a one-page explanation, but I’ll try.

Biodiversity has many, many dimensions, some of which might be grouped into bundles labelled composition, structure, dynamics and function. We can measure and set targets related to some elements of composition, including - at least in theory - the identity and variety of genes, populations or species, and we can establish various measures of genetic and species diversity.

Structural measures and targets are generally more problematic. For example, while we can perhaps measure characteristics of isolation and connectivity of patches, the complexity that goes to create habitats make target-setting difficult. It is not at all easy to imagine targets that would relate to the dynamics between the elements that create that habitat, the changes within gene assemblages, populations and communities and the ecological and evolutionary processes that emerge. We just don’t understand complex systems with non-linear feedback well enough, which is one of the many reasons I dislike the push towards identifying thresholds.

Functional measures of biodiversity, including energy and nutrient cycling, may in some circumstances prove easier to measure and to set targets for. But many people see biodiversity as extending to ecosystems and the services they provide to living things, including humans. And indeed, many people recognise that humans, along with their values, culture, institutions and technology, are part of biodiversity. But people are diverse; we don’t necessarily share values, goals, or world views. This makes it considerably more difficult to set targets, even along the relatively simple compositional group of axes. This is easily illustrated. More biodiversity in one dimension is not necessarily good - after all, having more troublesome non-native species in an area at the end of a period than at the start does not necessarily mean that biodiversity in that area is somehow better. But even that depends on the point of view of the person assessing it. To a gardener who likes bamboo, a garden-full of various invasive bamboo species might be a delight, while to an ecologist it might be a horror.

By extension, it is easy to see that it is meaningless to set a single target for “biodiversity”. Things can vary along their many dimensions in ways that would make such a measure meaningless, often misleading. One might imagine a case in which various compositional aspects were changing in one direction while functional aspects were unaffected and at least some structural aspects were changing in another direction. Could we then agree at any point that we had “halted the loss of biodiversity”?

As for “managing” biodiversity, I contend that we can only manage in any meaningful way ecosystems that are hugely simplified - unless, that is, we define leaving a place alone as a kind of management. And historically at least, management, in general, starts by simplifying the ecosystem, or even sweeping it away and replacing it.

My strongly-held belief is that we cannot achieve whatever it is we are trying to achieve by setting targets “for biodiversity” and treating and managing “biodiversity” as a thing apart, untouched somehow by all the other things that humans have done and are doing to modify this planet. This, it seems to me, is suicidally wrong-headed. I think we need a

much deeper and more thorough re-thinking of our place on this planet and how to make it sustainable.

That, then, is my single over-riding research requirement. What I have said here only touches tangentially the surface of a very complex problem. If you're interested in a rather deeper discussion of that problem, please see appendix 1.

RE: The wicked problem of biodiversity

Jiska van Dijk, Norwegian Institute for Nature Research, Norway

The problem of biodiversity is not easy, I agree, but the problem of climate change isn't easy either. If the equivalent to "stopping climate change" is the 3-word "greatly reduce emissions" than it assumes that climate only changes because of the emissions. If no emissions there will be no climate change. Is this what we really mean or is the process more complicated and at least the time period for which climate change is acceptable should be included in the discussion?

Furthermore can we actually expect a 3-word equivalent for "stopping biodiversity loss" as "greatly reducing emissions" is for "stopping climate change"? These two, biodiversity loss and climate change, are actually two different processes. We shouldn't forget this. One is halt a loss and the other one is stop a change. However I think "stopping biodiversity loss" could very well be replaced by "maintain the variety of life on earth". Maybe the problem of biodiversity itself is not that wicked if you look at it in a simple way. It becomes wicked however since we connect biodiversity, as we do, immediately to ecosystem functioning and ecosystem changes. But for ecosystem functioning complicated interactions come around the corner that the variety of life induces. Processes that we simply do not know how it all works. What we do know is that a certain variety of life is needed to maintain ecosystem functioning. So by setting the target for biodiversity on biodiversity itself while implying that we deal with ecosystem functioning is bound to give a poorly formulated target. Biodiversity is one, ecosystem functioning is another and ecosystem services is yet another one. Setting a target for biodiversity does not necessarily facilitate the processes we would like to see on the level of ecosystem functioning.

However the concept of "stop climate change" is maybe relatively easy to understand for society. Biodiversity is already a more difficult concept for most of us. Most insects are creepy, and the need for different rice species in Africa is not apparent when Uncle Ben's rice is served during dinner. So in bringing the concept of ecosystem functioning among society it is maybe only feasible when communicating about "stopping the loss of biodiversity". What we then shouldn't do is blame ourselves for a poorly formulated target or even worse blame ourselves for not having reached what we thought we needed to reach. Who are we talking to/with: scientists, politicians, tourists? What is it that we are talking about: biodiversity, ecosystem functioning, ecosystem services and above all what do we want?

RE: The wicked problem of biodiversity

Dave Stanley, Independent sustainability consultant, UK

There are 2 phrases that I regularly use to further any discussion on sustainability. The First is "if you don't agree the problem then you don't agree with the solution" and the second is "beware single issue environmentalism". OK so in this instance "biodiversity" is the most critical – terrestrial and marine. Both statements, I would suggest, are apt for the current debate.

However, to nail a problem we need to nail the terminology. Biodiversity loss, Climate Change, pollution, resource consumption, acidification etc are not problems. They and a whole load more are "negative impacts" – sometimes referred to as "indicators" - that arise or are triggered by (largely economic) activities that are themselves driven by the problem. By

their very insidious nature the “negative impacts” – biodiversity loss, Climate Change, acidification, pollution etc are diffuse, diluted, dispersed and because of their complexity difficult, if not impossible, to clearly identify, describe, quantify and measure. This is very convenient for those who do not wish to know, or understand the fundamental principles of how the planet functions and prefer a short term (economic) perspective. A good stall is requiring “sound science” to research and prove the “problem” prior to possibly addressing with policy action.

Furthermore, nobly setting targets for a reduction in a single negative impact typically results in exasperating impacts elsewhere. Two quick examples – both on the (single issue) impact of Climate Change and the perception that the “problem” is CO2 emissions (actually the aspect in ISO14001 jargon) – CCS will require more resources to produce the scrubbing system and more energy to operate and compress/pump the CO2 – RTFO switch to biofuels has had a devastating impact on biodiversity, and ignores the 30% of any CO2 or so that goes to acidifying the oceans. In short targeting impacts, including biodiversity loss, typically does not work for the simple reason it is “end of pipe”. It makes as much sense as addressing obesity by setting targets for effluent reduction.

So if we go to the front of pipe, we could identify the problem that is the cause of most, if not all, of the negative impacts. It is currently well measured, quantified and costed. It is therefore readily targeted. Directly tackling the problem is more likely to benefit “biodiversity” because it addresses the “cause”.

RE: The wicked problem of biodiversity

Dave Stanley, Independent sustainability consultant, UK

In the first page of his attached paper, Martin Sharman argues that:

“A text-book example of a wicked problem is this: what must we do to stop the further loss of biodiversity? If we can answer that question, then we can begin to set sensible targets. What is the cause of the loss of biodiversity? We can not point to a single driver like ‘humans are transforming fossil carbon into greenhouse gas’. Instead it has many linked causes. They include profit-driven, growth-based economies, a growing human population with steeply increasing demands on the living world, ineffective institutions, poverty, accounting that externalises environmental costs, greed, war, protectionism, climate change, lack of political will, subsidies, corruption, inequitable access to the benefits of living resources, wilful ignorance, and a global trade regime fit for a different planet. All of these causes also help to change the composition of the atmosphere, but in every case, we can point to one cause: emission of greenhouse gases. In that tangle of causes, can you or anyone else say where, exactly, lies the cause of loss of the living fabric of our planet?”

I would suggest that none of this accurately identifies THE Problem, although the paper does subsequently touch on it. Certainly greenhouse gas emissions are not the one “cause”, who is to say that the disruption of the nitrogen cycle or impact of acidification may not, with hindsight, prove to be the biggest gotcha?

Researching what we preach

Adrian Manning, Australian National University, Canberra, Australia

By 2020 we should be researching what we preach, starting with rethinking our questions.

Thomas Jefferson said ‘people get the government that they deserve’. This could be said to equally apply to biodiversity, and the biodiversity we are getting does not reflect well on our stewardship of planet Earth. Despite our best intentions in policy, research and action (and many local successes), on the broad-scale we have failed to meet our 2010 biodiversity target. This demands some serious reflection.

Rethinking our questions: It is not clear that applying our current approaches more resolutely is going to resolve the biodiversity crisis. The statistician John Tukey wrote: ‘Far better an approximate answer to the right question, which is often vague, than an exact answer to the wrong question, which can always be made precise’. Before deciding what research we want to undertake, we need to reflect. Are we asking the right questions? Are we funding the right questions? The process of reflection should include more than researchers and policy-makers, but also wider society.

Researching what we preach: In recent decades, new terms have emerged that describe alternative approaches to protecting and enhancing biodiversity; particularly in response to climate change. Some examples include: ‘whole-landscape management’, ‘landscape connectivity’, ‘ecosystem management’, ‘climate adaptation’, ‘ecological restoration’, ‘resilience’, ‘landscape-scale management’, ‘adaptive management’, ‘re-wilding’, ‘ecological networks’. All have sound ecological underpinnings, and commonly appear in policies and strategies, but are not widely practiced. To apply them, we must understand them, to understand them we must research them, to research them we must fund that research. The centre of gravity of biodiversity research needs to move in this direction.

Large scale and long-term research (and funding): Many of these new approaches focus on complex phenomena, which change over long periods and large scales. Research, policy and actions must reflect this, as must the lifespan of funding and research projects.

Research funding should have direction, but not be too prescriptive: Addressing the biodiversity crisis will require creativity. Researchers must be afforded time for free thinking. Creative research does not always have to be costly, but it is more difficult than we think. Often funding pre-supposes that we know what the answer should be – this runs contrary to scientific principles. We must make space for serendipity and the pursuit of unexpected lines of enquiry in research, particularly with the uncertainties of climate change.

Integration of research and ecological restoration: Increasing levels of monitoring by 2020 will be critically important in following trends in biodiversity. However, if we look at the biodiversity speedometer alone, it tells us nothing about the causal foot on the accelerator and brake. Understanding cause and effect is critical to managing adaptively. Conservation and ecological restoration projects that manipulate the environment offer excellent opportunities for well-designed ‘learning by doing’ experiments. To succeed and have longevity, such projects require partnerships involving land managers, researchers and statisticians, and the requisite support through policy and funding.

Biodiversity should not require micro-management. It should be a by-product of how we manage our landscapes sustainably in the future. However, harnessing ecological processes will mean ceding some human control over ecosystems, and in some places, all human control. These future landscapes may be quite different to the ones with which we are familiar, and will be a mix of old and new land uses. By 2020 our research agenda should be helping us better understand how to create these landscapes.

Goals, actors and mechanisms for biodiversity targets

Felix Rauschmayer, Helmholtz Centre for Environmental Research, Germany

Summary: I argue that we first have to identify the goal of a new target, then the actors this target aims to touch, thirdly the mechanisms to discuss and decide on the target. A better understanding of the experience with the 2010 target in political circles is an essential learning process for any new endeavour.

Recapitulating the timeline of the 2010 target, I immediately notice that any of these targets were unrealistic from the beginning (even though insufficient from the point of view of many people). The aim was, to use a metaphor, to reduce the speed of a train that is in plain acceleration process. As we all know, there are reasons for this acceleration process: increased consumption, increased pollution, and increased population with all their correlates (e.g. more trade, more biological invasions ...). So the target could only have been reached by decreasing the pressure from these drivers, at least in large areas of the world. From the very limited political power of biodiversity (or environmental) policy and the non-triviality of solutions (in ethical and technical terms), it seemed to be clear from the beginning that the target could not be reached. However, one might say that the target can be considered a success story nevertheless, as Stefan Leiner partly claims. Biodiversity policy is increasingly present at all levels and some efforts were made to get closer to achieving the target. Would a weaker and more realistic target (or a stronger and more ambitious one) have done the same job? Before judging the target, we might want to look into the goals of the target:

What was the aim of the target?

- Was the aim to set an achievable goal? Then it was a bad target; but as Stefan Leiner suggests, it guided policy nevertheless in a somewhat different direction.
- Was the aim to draw attention to the complexity of the issue (e.g. by discussing indicators and sub-indicators, DPSIR-models etc.) and learn more about it? Did it reach this goal? Here again, Stefan Leiner is positive about this for the EC.
- Was it to draw attention to a field of political action? Then, perhaps, it met its objectives, as now, we can say: “look, this was really a very moderate target with respect to what humans need for a decent survival in the short or middle term - and even this was not achieved”
- Was it to motivate action? Here, I am dubious. Being too moderate (for some) and too ambitious (for others) at the same time, it might not have had the best impact. And not meeting a target might stimulate more action or frustrate activists.
- Or was there some other goal?

And what should the goals of a post-2010 target be?

- Who were the main addressees of the target? Probably governmental and supra-national agencies. Are these the main addressees of a post-2010 target? How is best to address them and how is best to address other actors in any of the sectors driving the continuation of biodiversity loss?
- What are good mechanisms to discuss a new target, to decide about it, and to disseminate it in order to have the ownership of the relevant actors?

Dealing with these political questions is probably more important for the success of a new target than inputting biodiversity sciences into indicators. A better understanding of what really went on with regard to the 2010 target in political circles is essential if one wants to learn from this experience.

Natura 2000 not a burden but an opportunity for sustainable economic growth

Jan Jansen, Radboud University Nijmegen, The Netherlands

Summary: We need to search for a redirection of rural development by considering the Natura 2000 network not a burden but an opportunity for sustainable economic growth. So far Natura 2000 is frequently received by land users as a rather fixed and isolated juridical network in spatial policy merely aimed at protection and conservation, which does not yet allow for a gentle interplay with socio-economic realities. However in the past habitat sizes changed significantly under natural conditions, and when humans entered the ecosystem, biodiversity became largely linked to land-use systems being part and an outcome of socio-economic developments. A flexible approach of Natura 2000 may be better suited to guarantee biodiversity on the long run, while both capturing new opportunities from socio-economic developments and climate change.

Indeed as Jeffrey McNeely pointed out, maintaining life on earth should be seen not as a burden, but cast in much more positive terms if we are actually to convince all sectors to contribute.

Let me give it a try by stating that we need to search for a redirection of rural development by considering the Natura 2000 network not a burden but an opportunity for sustainable economic growth.

The Natura 2000 network in the European Union aims at maintaining a favourable status of species and habitats listed in the Habitats Directive. So far Natura 2000 is frequently received by land users as a rather fixed and isolated juridical network in spatial policy merely aimed at protection and conservation, which does not yet allow for a gentle interplay with socio-economic realities. However in the past habitat sizes changed significantly under natural conditions, and when humans entered the ecosystem, biodiversity became largely linked to land-use systems being part and an outcome of socio-economic developments.

It is an 'idée fixe' to think that we can protect habitats if we would be able to keep them as they are. History shows that landscapes always have been subject to changes. It is also an 'idée fixe' to think that we can preserve biodiversity by fencing off habitats in nature reserves. Here history also shows that there has always been interplay with socio-economic developments some of which have been initiated by political-administrative measures.

Most of the European agro-pastoral infield-outfield systems stayed economic profitable until the end of the 19th century. In some places these systems developed as a flywheel for market-oriented economic development. There was a shift from the primary sector to the second and tertiary sector. Policies intervened to steer to economic more profitable land-use systems. In the course of the 20th century outfields became forest plantations, arable land (due to artificial fertilizers) or... nature reserves.

Now, a century later, a major part of the species and habitats of the Natura 2000 network is found in the former outfield areas. But nature conservation and economic growth are difficult to reconcile as is clear from the many ways that economic expansion, including the productivity increase in agriculture, has to be compensated elsewhere. Competitive farming in the global agricultural market is no longer an option in the Less Favoured Areas (LFA's). Instead Natura 2000 is a possible vehicle to reconcile farming for niche markets supplying services including the provision of biodiversity, clean water, fire protection, and attractive landscapes preconditioning opportunities for tourism and rural enterprise.

The Common Agricultural Policy (CAP) has been a success in terms of increasing agricultural production and, since its introduction in 1962, the EU has developed from being an importer to a major exporter of food. Now most of the food needed in the EU can be produced on a relatively small area of farmland. Unintentionally the CAP has been one of the driving forces behind the loss of social cohesion and the decline of ecosystem functions,

landscape quality and cultural heritage⁵. A new challenge for the CAP therefore is to invest in the LFA's that cover already more than half the territory, not for massive food production but rather for other services.

Clearly we need to define sustainable land-use scenario's, in which biodiversity objectives and the socio-economic conditions can enforce each other, which is a factor sine qua non to achieve the Natura 2000 goals in the EU.

Natura 2000 is a powerful tool but the increasing extent of legal regulation and book keeping can result in the opposite effect. I think I do understand the fear both from nature protectors, but also from businessmen and arguing in court between lawyers is not exactly the best place to enhance a better interplay between entrepreneurs and ecologists. Therefore, a flexible approach of Natura 2000 and a bridge to other political-administrative tools such as the CAP may be better suited to guarantee biodiversity on the long run, while both capturing new opportunities from socio-economic development and raising resilience of the local eco-infrastructure to globalization and climate change.

⁵ Position paper REP 2008 (Rural European Platform)
<http://www.ruraleuropeanplatform.org/docs/PositionPorto>

Towards a 2020 biodiversity target: how can the loss of biodiversity successfully be halted?

Johan Bodegård, Wenche Eide, Anna Karlsson, Artur Larsson, Tor-Björn Larsson, Johan Samuelsson, Malin Strand, Lena Tranvik & Mattias Wallén, Swedish Species Information Centre.

The 2010 biodiversity target to reduce/halt biodiversity loss has been of major importance for the political support to nature conservation and actions for biological diversity in the European Union and globally. This positive impact is recognized despite the emerging insight of the failure to fully achieve this target. In line with this, Sweden plans, during the EU presidency autumn 2009, to propose a new long-term biodiversity target. As part of the preparations for the EU Environment Ministers meetings the Swedish Species Information Centre thus organized an electronic conference inviting a wide range of national contacts to present ideas and opinions on the work to halt biodiversity loss during the last decade.

The main outcome of the conference was the following proposal for a new political biodiversity target:

Safeguarding healthy ecosystems: To ensure that (by 2030) economic and social development is carried out within the boundaries of healthy ecosystems, delivering long term benefits to humankind.

Among the comments and suggestions given related to the target the following should be considered:

- An alternative formulation of the target, capitalizing on the positive effects of the 2010 target, could be: ‘safeguarding healthy ecosystems and halting biodiversity loss: To ensure ...’
- The suggested target is visionary and presenting a precise year for achieving this might be debated.
- A visionary long-term target as the one suggested should be supplemented through time-specific sub-targets and/or targets for actions.

As a basis for presenting a new long-term biodiversity the conference participants discussed what had been the major threats to biodiversity and obstacles to halting the loss of biodiversity during the last decade and the actions needed to reverse the development. Research was not the main focus of the conference but the lack of knowledge was nevertheless highlighted as one of the major obstacles for successful biodiversity policy and actions in e.g. the marine environment. Scientists pointed at a better understanding of the processes and functions of the marine ecosystems to be able to design relevant monitoring programmes. Forests get a lot of attention in Swedish biodiversity discussions and so was the case also in this conference. A main issue is how to combine forestry - economically important in Fennoscandia - with biodiversity concerns. We still need a better understanding of possibilities to conserve and enhance biodiversity on land also used for production of timber and other forest goods.

What research do we need to set and monitor biodiversity targets for 2020?

Daniel P Faith, The Australian Museum, Australia

We do not need to abandon the 2010 target of reduced rate of biodiversity loss – we need to abandon our weak approach to it. An approach that is linked to the idea of achieving new balances/synergies, with both wholesale biodiversity and other needs of society on the table - means that we can have a realistic, achievable, target for a reduced rate of biodiversity loss.

The interest in targets ‘beyond 2010’ seems to be based on a perceived inability to achieve the 2010 biodiversity target (‘a significant reduction in the current rate of biodiversity loss’). However, I think we need to re-consider our typical perspectives on the 2010 target. I propose that:

1. A goal to achieve a reduced rate of biodiversity loss is achievable,
2. A biodiversity target/goal that truly is about ‘biodiversity’ (=living variation), will incorporate consideration of overall biodiversity, including the vast amount of biodiversity that is still unknown to science, and
3. At the same time, a successful approach to a biodiversity target must stop focussing just on ‘biodiversity’ and explicitly include other needs of society.

We need indicators for beyond-2010 targets that do not simply look at biodiversity on its own, but consider how efficiently we can balance biodiversity conservation with other needs of society. Because achieving a balance achieves biodiversity conservation with lower opportunity cost (in terms of other needs of society) it can mean a reduced rate of biodiversity loss. We refer to such efficient, balanced, planning and conservation strategies under the broad umbrella of ‘systematic conservation planning’ (SCP). Simply put, land-use planning and other decision making that more efficiently balances conservation with other needs of society implies reduced biodiversity losses, compared to business-as-usual⁶. Thus, future achievable targets can justifiably continue to focus on a significant reduction in the rate of loss of biodiversity.

This approach suggests at least three research areas:

- The SCP approach depends on good measures of overall (wholesale) biodiversity. Research might focus on how existing biotic data can be integrated, in ‘surrogate’ strategies, with environmental data to extend the predictive power of biodiversity models (e.g. based on new community-level approaches). Research is needed to ensure that models of overall biodiversity are robust enough to be used in indicators. Similar models can incorporate genetic diversity, perhaps by extending the innovative approaches used at the regional and global scales by microbial workers (see references).
- These biodiversity models must be integrated with socio-economic, threats, and land/water use data for SCP. Research is needed to determine the particular planning and conservation instruments that are most useful for achieving efficiencies in different contexts. This research will be relevant to the development of policies relating, for example, to payments to private land-owners, eco-forestry, collaborative benefits from carbon offsets, etc.
- Research is needed to determine how to monitor, at the regional and global scales, not only biodiversity losses, but also achievements in implementing SCP type approaches. Indicators can either trace estimated changes in rate of biodiversity loss, or may simply record and in some way credit new implementations of SCP. Research opportunities to implement monitoring linked to 2020 targets exist through links to GEO BON (see references). For example, we need to develop approaches that can use remote sensing to supply time series on change in condition of land, and then interpret this information through the biodiversity ‘lens’ provided by robust global biodiversity models.

⁶ see example figure at <http://australianmuseum.net.au/image/Figure-2010-regional-tradeoffs>

Conclusion - My suggestions for the development of targets and indicators for 2020 is based on the idea that the 2010 target was OK, but our approach to addressing it was not. A 2020 biodiversity target could remain much the same as the original. But it requires research to develop acceptable, robust, models for overall biodiversity, research to develop indicators of success for the policies implementing efficiency, and research on how to carry out ongoing monitoring. Such new research is needed, so that we can avoid “dusting-off” old indicators, and avoid falling back into focussing only on well-known, easily measured, supposedly-most-important components of biodiversity.

RE: What research do we need to set and monitor biodiversity targets for 2020?

Alessandro Gimona, Macaulay Institute, UK

I am not entirely sure that we need to throw more science at the problem of missing the 2010 target. Decision makers miss targets because there are barriers to implementation and also because they have a number of other priorities to juggle with.

We can suggest all the revised targets we like, but, if the political and institutional causes of the problem are not well understood, I suspect we will be here bemoaning missing the new target (...unless the target is so meaningless that achieving it would be very easy).

In my opinion more attention needs to be devoted to how knowledge is transferred from research to departments who are supposed to implement policy on the ground and to their technical capacity needs. They might need help with how to implement a new policy.

The same applies to land managers and their advisers. For example, many land managers don't know about any existing biodiversity documents, nor do they know what landscape-scale conservation means or how it has anything to do with them. So the existence of incentives per se is not sufficient, although it is necessary.

The consequence is that glossy biodiversity documents often remain nice to look at but not useful in practice. Capacity building at all levels is expensive and new practices can disrupt the ‘business as usual’ culture so needs to be made easy to embrace for public organisations and land managers. Hence political commitment needs to extend to removing any existing barriers...but we have to understand better what these are and how the system really works.

In conclusion I suggest more research is devoted to finding out what the barriers to implementation of policy are for land managers and for all levels of government.

RE: What research do we need to set and monitor biodiversity targets for 2020?
The SCP approach

Daniel Faith, The Australian Museum, Australia

In my first submission, I nominated some research priorities, based on the idea that a 2010-type target can be achieved through implementations of balanced conservation planning. I argued that:

- “We need indicators for beyond-2010 targets that do not simply look at biodiversity on its own, but consider how efficiently we can balance biodiversity conservation with other needs of society.
- Because achieving a balance achieves biodiversity conservation with lower opportunity cost (in terms of other needs of society) it can mean a reduced rate of biodiversity loss.
- We refer to such efficient, balanced, planning and conservation strategies under the broad umbrella of “systematic conservation planning” (SCP).
- Simply put, land-use planning and other decision making that more efficiently balances conservation with other needs of society implies reduced biodiversity losses, compared to business-as-usual

- Thus, future achievable targets can justifiably continue to focus on a significant reduction in the rate of loss of biodiversity.”

I would like to link my previous contribution to some of the other submissions made over the past two weeks. My feeling is that many useful comments have been made, and many of these point in the same direction: there is a need to approach this issue in a more integrative way, and have all of society’s needs on the table. I therefore see many of these comments as indirectly supporting my proposed “SCP” (systematic conservation planning) approach.

For example, in his submission, Allan Watt said:

“The focus on indicators inevitably means that the role of people not only in driving biodiversity loss but also in taking action to address it tends to be ignored.”

And in his submission, Martin Sharman said:

“My strongly-held belief is that we cannot achieve whatever it is we are trying to achieve by setting targets “for biodiversity” and treating and managing “biodiversity” as a thing apart, untouched somehow by all the other things that humans have done and are doing to modify this planet.”

And in his submission, Jeff McNeely said:

“... policy goals of governments seem to favour over-exploitation above sustainable use, judging from observable behaviour and research findings of the Millennium Ecosystem Assessment. The combination of the poor formulation of the target and the conflicts between different policy goals results in the observed poor governance of biodiversity at national, regional and global levels.”

With reference to these comments, I think that a new indicator (for a goal/target seeking a reduced rate of biodiversity loss) crediting new implementations of SCP satisfies several concerns. It may properly integrate biodiversity and those “people” factors. It may help to reduce the degree to which a goal of reducing biodiversity loss seems to be in conflict with other “policy goals”. It may help to reduce the degree to which a goal of reducing biodiversity loss seems to neglect “all the other things that humans ... are doing”.

I note some other relevant comments.

Martin Sharman’s attachment paper says this: “If we absolutely need targets, let them be ones that encourage movement along the road of sustainability.” The paper also notes the need to “establish and sustain a balanced relationship between humans and the rest of the living world.”

I agree with these statements, and see the pursuit of “balance” through SCP as “movement along the road of sustainability”, because one good definition of sustainability is based on the idea of balancing different needs of society.

In his first submission, Peter Bridgewater said: “The DIVERSITAS programme was established with the aim of promoting such research, yet still there is little integrative research emerging. As we approach 2010 we need to refocus our efforts on this theme of integration...”

I think that DIVERSITAS will continue to play an important role in promoting the needed integrative research in support of targets for biodiversity beyond 2010. This topic will be discussed at the upcoming DIVERSITAS Open Science Conference in Cape Town in October.

Biodiversity: moving from loss to gain

Paul Goriup, Fieldfare International Ecological Development, UK

I have to admit that I gave a very wry smile when I first learned about the European Environment Ministers adopting the 2010 target. I didn't think it was any more than a slogan and I don't know any other colleague who thought it could be achieved (especially when halting was so much tougher than the global target of reducing biodiversity loss). Why not? Well, most of the reasons have already been spelled out in previous posts:

'Biodiversity' is an ineffable concept that cannot be quantified in the same way as physical/chemical indicators so there is no single threshold to aim for; the current set of 26 SEBI are far too many for easy comprehension (and several are auto-correlated).

In a Continent as thoroughly modified as Europe since the advent of Neolithic man, what ecological conditions inform our baseline – the post-glacial, post 1800 (as for the new bird assessment for the UK), post 1900, mid-1960s (as for the Bucharest Convention on the state of the Black Sea) or fixing Europe's range of habitats and species in the Natura 2000 network derived from ca. late 1990s Birds and Habitats Directives as amended (i.e. expanded but not re-assessed) for EU27? Not to mention the convenient modification or disaggregation of targets to suit funding/campaign/policy needs.

Someone's perceived biodiversity gain can be someone else's loss, leading to zero sum games (on my local patch between those who want bracken for adders versus those who want to remove it to encourage silver spotted skippers).

And, for me the most alarming, that according to the recent EEA report on SEBI, an opinion poll on biodiversity held in November 2007 found that two-thirds of EU citizens do not know the meaning of the word 'biodiversity', or understand the main threats to biodiversity. However, when the issue is explained to them, more than two-thirds consider the loss of biodiversity a serious problem, albeit more so at the global level. Europeans believe pollution and man-made disasters to be the main threats to biodiversity.

Since I strongly believe the threats to biodiversity, as in climate change, stem from the aggregate actions of all of us, I think the formulation of the 2010 target was not only unrealistic (and therefore self-defeating) but also psychologically negative at the individual level – who can "halt" biodiversity loss? I suggest we need a more positive message, like achieving better biodiversity, which anyone with a will can do. I believe we have to take stock, and research some fundamental rules and establish a few easy-to-understand standards that can lead to improvements in our ecosystems. There are a number available already: no extinctions; achieving favourable status for rare habitats and species; extent of terrestrial and marine protected areas.

Despite my background as a bird conservationist, or perhaps because of it, I do have some inchoate doubts about multi-species bird population indices and how much they really tell us about ecosystem change (after all, a farmland bird in the UK, like a yellowhammer, is a forest bird in Romania). I would prefer selecting some key bird species and acting to improve their overall status (pulling habitat restoration and maintenance with them) which would be much more meaningful for people: it would be interesting to research the ecological benefits from recovery of avocets, ospreys and red kites compared with actions based on the latest twist in the CBC index.

Finally, the achievement of better biodiversity in Europe means public support (if not engagement) and resources. Hence two indicators that really need research and beefing up are those concerning public awareness and finance. The former needs more attention from sociologists. The latter presently covers only EC expenditure as a proportion of its own budget. I suggest expanding it to cover governments and the private sector as a share of national/EU GDP. That is an area for ecologists and economists to get to grips with. I happily admit that that 2010 target mobilised far more policy attention than I expected (the IUCN 2010 Countdown was an important player here). However, the fact we have to talk about a post-2010 framework shows the effects on the ground were modest. We have the chance now to move from the language of losing to that of winning.

The (post 2010) target and interdisciplinary research

Ben Delbaere, ECNC-European Centre for Nature Conservation, The Netherlands

When discussing what research is needed in relation to the post 2010 biodiversity target or framework some of the previous contributions to this e-conference already highlighted the need for a strong role for social science. I would strongly support this, although it has to be in combination with natural science.

The 2010 target (like most biodiversity objectives) reflects a political decision and should therefore not be scrutinised from a scientific point of view, however there is much to be criticised about it. I agree with those of you that highlighted the stimulus that the 2010 target has given to efforts at all levels to contribute to conserving biodiversity, in whatever form (not least in the field of indicators, involving regional authorities or the business community). Without such (immeasurable) target the development of biodiversity indicators or the cooperation between various stakeholders as coordinated through the Countdown 2010 process would not have progressed this far.

Nevertheless, science has a strong role to play with regard to the target. Social science can look into issues that were already raised by Allan Watt and Felix Rauschmayer: Why does one set a target? What is the expected result in terms of behaviour and attitude, and by whom? How is a target set, who is involved? What is the role of lobbying, power, the various governance levels, communication, or the messenger? Are SMART formulated targets more effective than targets that rather express an intention? Questions that natural sciences should continue to be concerned with when considering a biodiversity target are those on the definition of biodiversity (see input by Martin Sharman and Jiska van Dijk), how it can be measured in a meaningful way, whether the same target for different geographical levels makes sense, or how changes in biodiversity relate to the health of ecosystems, as now proposed as a target by the Swedish electronic conference.

Clearly interdisciplinary research is essential, given the strong connection between science and policy when discussing the 2010 target. The types of questions listed above are closely interrelated and should therefore be looked at in a holistic way. Much has already been achieved in this sense⁷ and a number of research networks, such as ALTER-Net, provide the platforms for taking such interdisciplinary research further and for prioritising those research questions of highest potential to contribute to any biodiversity target beyond 2010, communicated in such a way that taking action for biodiversity is not seen as a burden but as something that goes without saying.

⁷ The outcome of the FP6-funded project SoBio - <http://www.ecnc.org/publications/technicalreports/social-science-and-biodiversity>

Biodiversity targets: local people and researchers

Zakir Hossain, Barisal, Bangladesh

The following is required to improve biodiversity targets in the future:

1. Research on the style of integrating local people with the biodiversity conservation issue
2. Re-establish the connection between people and local biodiversity
3. Translate all relevant policies, laws and regulations to understandable local dialect
4. Confirm biodiversity and research ownership
5. Free the biodiversity issue from corporate greed
6. Expand territories of biodiversity from merely environmental issues towards total development issues
7. Develop in-situ conservation targets

RE: Biodiversity targets: local people and researchers

Maria Fonte, University of Naples Federico II, Italy

I thank Zakir Hossain for highlighting very important key concepts and key words for the consideration of any 'biodiversity target' - i.e. 'local people'

As far as agricultural biodiversity is concerned, re-connecting biodiversity issues to local people means raising questions about models of development, especially models of agro-food production and consumption based on the dominance of agro-industry and food retailing corporations. It means questioning the way knowledge is generated, diffused and appropriated; how priorities and targets are set; and methodologies are chosen and applied. It means opening public spaces and hybrid forums where 'controversies' on biodiversity can be created and discussed not only by 'scientists' but also by 'lay' persons: farmers, especially small farmers, food producers, especially artisan-food producers, citizens-consumers.

Following Martin Sharman analysis, the target should be to make 'biodiversity' the focus of a public debate on 'the relationship between humans and the living world', letting a dialogue between experts and lay persons to develop, suggestions and proposal to emerge and be appropriated at different levels, but being especially attentive to poorer people and rural communities - who have managed natural resources for centuries - to ensure they are not excluded.

RE: Biodiversity targets: local people and researchers

Betty Stickers, Shetland breeder, The Netherlands

I cannot agree more with Zakir Hossain. I'm talking from the viewpoint of agriculture. Countries have an obligation not to diminish the FanGR (Farm Animal Genetic Resource). It is important that we combine all existing networks regarding conservation of rare and traditional breeds of all categories of animals, plants and agricultural products in order to:

- Heighten public awareness on the use of traditional products (animals and agricultural)
- Promote the assets of these products and use rare and traditional breeds for production as the only way to preserve rare breeds
- Transform stock-breeding farms into dual-purpose farms
- Educate and inform the public
- Encourage cooperation by small scale farmers to prevent erosion through the current trend to large-scale farming. The later is an undesirable scenario for traditional breeds and world food security.

Tristan Tyrrell, UNEP-WCMC, Cambridge, UK

In 2010, Parties to the Convention on Biological Diversity (CBD) will review the extent to which progress has been made in meeting the global biodiversity target, and to develop a new, post-2010 strategic plan and associated target(s). Progress towards the 2010 target is being tracked using a framework of indicators and the extent to which policy-makers and society will be able to assess their achievements, and identify suitable responses, is largely dependent upon the information provided by such indicators.⁸ In July 2009, the Secretariat of the Convention on Biological Diversity (SCBD) and the UNEP World Conservation Monitoring Centre jointly convened a meeting to review the use and effectiveness of the 2010 biodiversity indicators and to consider the implications for the development of post-2010 targets and indicators. The meeting was hosted by the UK Department for Environment, Food and Rural Affairs (Defra), whilst additional financial support was provided by the United Nations Environment Programme (UNEP), the European Commission (EC) and the UK Joint Nature Conservation Committee (JNCC). The workshop brought together over 70 participants including government-nominated experts and representatives of biodiversity-related conventions, UN agencies, academic and research institutions and other relevant international, intergovernmental and non-governmental organizations.

The meeting crafted a series of recommendations of which the following were voted the most important:

- A small set of (10-15) broad headline indicators, clearly linked to the main target and sub-targets and underscored by more specific sub-indicators/measures, should be maintained/developed, in order to communicate the indicator set through key storylines and clear, policy relevant messages, while maintaining a flexible framework to cater for national/regional needs.
- The current framework of global indicators should be modified and simplified into four 'focal areas': Threats to Biodiversity; State of Biodiversity; Ecosystem services; and Policy Responses. Existing indicators should be re-aligned with the new framework, as appropriate, in order to maintain continuity and enhance their use. The relationships between the focal areas and between indicators and targets should be clearly explained and documented, including their scientific basis and assumptions.
- Some additional measures on threats to biodiversity, status of diversity, ecosystem extent and condition, ecosystem services and policy responses should be developed in order to provide a more complete and flexible set of indicators to monitor progress towards a post-2010 target and to clearly link actions and biodiversity outcomes to benefits for people.
- National capacity for framework application, indicator development, data collection and information management should be further developed and properly resourced in order to strengthen countries' ability to develop, monitor and communicate indicators in a participatory, sustained and integrated way; and to link with other processes e.g., MEAs at all levels.
- Priority must be given to developing a communication strategy for the post-2010 targets and indicators in order to inform policy discussions and ensure effective communication of messages coming from the indicators into all sectors (including inter alia delivering stories relevant to human well-being, identifying champions, promoting a regular reporting process, etc).
- A flexible and inclusive process/partnership for post-2010 indicator development should be maintained and adequately resourced in order to increase collaboration in the development, quality control, implementation and communication of indicators at all levels, including the sharing of experience and the building of capacity.

⁸ The full report of this meeting will be made available via the CBD website from the week beginning 14 September 2009.

The role of the Habitat Directive in halting biodiversity loss

Ferdinando Boero, University of Salento, Italy

Biodiversity represents a natural capital. The first problem, when managing and protecting a capital, is to make its inventory. The EU, with the Habitat Directive, identified the Habitat as the cornerstone level to manage and protect biodiversity. The Habitat Directive considered mainly terrestrial habitats, and neglected marine ones, with very vague items. Reefs or Inlets and Coves are almost everything and run the risk of being nothing.

We need an agreed upon list of marine habitat types occurring in European waters. This is the first target. Many lists are available, with lots of confusion. Some are too detailed, some are too vague. We need a European Register of Marine Habitats, just as we made the European Register of Marine Species.

The second target is to rank habitats according to their vulnerability and unicity. Off shore muds, for instance, are less vulnerable than bio-constructions of any kind, from coralligenous formations, to seagrass meadows, to white corals.

The third target is to ascertain marine habitat distribution in European waters, with an accurate mapping of, at least, coastal bottoms from 0 to 30 m, where the mosaic of habitats is more complex and the impacts are more severe.

The fourth target is to associate community types and species lists to each habitat type, merging the European Register of Marine Species with the European Register of Marine Habitats, so to arrange communities and species in classes (e.g. exclusive of a single habitat type, present in, let's say, 2-5 habitat types, present in more than 6 habitat types). Community and species diversity, then, is to be associated with genetic diversity of the single species.

Habitat forming species are the most important ones, and especially bio-constructors, then there are functionally important species (e.g. keystone predators), then all the other species. One problem is: for how many species do we know the ecological role? We probably disregard very important species and concentrate our attention on some species just because they are charismatic. We need a more scientific and a less emotional approach to the problem.

The monitoring is to be made on:

- The boundaries of habitats. Is a valuable habitat shrinking, remaining stable, or widening? Of course modern GPS techniques are crucial for this exercise. This is currently being done for seagrass meadows throughout the Mediterranean.
- The community and species richness of crucial habitats (the same habitat can host very different species assemblages)
- The genetic diversity of species in crucial habitats

The very concept of stability is to be discussed, under this respect. Are we expecting that the present-day situation is to remain stable? What are the reference points?

I argued that a better state for a given habitat is represented by its richness (considering species assemblages, and genetic diversity). Once we have the master list of species for each habitat type (deriving from the ecological and the taxonomic literature), we can consider as "better preserved" the habitat that hosts the highest diversity.

The same habitat, hosting 100 species at site 1 and 55 at site 2 cannot be considered as having the same state of conservation (but we need to have the trends, of course). This is even more obvious when the habitat hosts the same type of community. But here we have the problem of invasive species, and also of the presence of species exclusive for that habitat. Warwick introduced interesting indexes of taxonomic diversity. Of course having 100 species of the same genus is not the same as having 100 species of 60 genera, and so on, going higher in taxonomic diversity.

I think that the habitat directive and the ecosystem approach are the right tools to pursue these objectives that are simply a restatement of their targets. They just need to be translated from theory into practice. The EU financed some network of excellence dedicated to these topics, but the NoE are at their end now, and it would be wise to use the people who created them, treasuring their expertise, not to reinvent the wheel over and over again.

The problem of management and protection. We must identify the vulnerability of each habitat type, stating the threats it is sensitive to. If we want to preserve a habitat (and the species inhabiting it) we must remove the stressors. Some stressors are global (e.g. global warming), and little can be done at a local scale to remove them. But other stressors are eminently local and can be managed.

Halting biodiversity loss, in this framework, is not synonymous with halting habitat loss. Subtidal rocks are a habitat type (the reefs of the Habitat Directive). They are not lost and so the habitat is not in peril. But the species assemblages inhabiting that habitat are vulnerable. Going back to sea urchin barrens and algal forests, it is easy to understand that these are two opposite states of species assemblages in the very same habitat type. It is not the habitat to be lost, it is the species assemblage inhabiting it. If the habitat is represented by a habitat forming species, however, there can be loss. For instance, with the regression of seagrass meadows, since seagrasses are habitat forming species (within their own habitat).

If we consider the species pool of each habitat, we might end up with lists of threatened species (to be further investigated at a genetic level). A species is in danger when it is absent at a great number of locations where its habitat(s) occur. Furthermore, it is even more in danger when its genetic diversity is severely reduced even at the sites where it occurs. Of course this is not always the case (see the genetically homogeneous cheetahs that, apparently, are not so threatened in spite of their low genetic diversity), but it might be taken as a general rule (with some exceptions).

This research will provide the knowledge about the diversity and distribution of habitat and species in the European waters, it will identify the stressors acting on them (but the problem of multiple stressors will have to be tackled), it will provide advice about the best practices on how to prevent biodiversity loss (by removing the stressors) and to evaluate if our action met the desired objects: if a stressor is removed, the habitat should improve its quality in terms of richness.

What is proposed here is a merely structural approach, based on WHAT is there. Then we should address the functional approach, aimed at understanding if the habitats we have are inhabited by species assemblages that are conducive to proper ecosystem functioning. This is a lot trickier. In many cases, ecosystem functioning is evaluated through the efficiency of biogeochemical cycles. If this is the case, then the role of bacteria becomes paramount, and the rest of biodiversity is almost irrelevant. Another way might be the evaluation of primary production, or the number of connections in trophic networks (e.g. the presence of top predators). We know that ecosystems function at very low diversity (e.g. the Baltic Sea) and at very high diversity (e.g. the Mediterranean Sea) and it might happen that diverse areas are less productive than monotonous ones. At this level we still need to find general rules to use as evaluation guidelines, and much theoretical, observational, and experimental research is still needed. Probably the rules are not general at all, and must be set on a case by case procedure.

The habitat level is the easiest to enforce and the inventory and the mapping of marine European habitat types might be obtained in a rather limited time, since the required expertise is not so great. It is just a matter of invested money. With proper investments, we can reach it in five years. If this is left to single states (and some are doing it) we will end up with different habitat lists and different maps. This is clearly a European enterprise.

The species level requires taxonomists, and this expertise is vanishing. This will require large investments in capacity building. The making of a taxonomist requires at least five years of training. We simply need to reverse the current trend: the investments must be in the long term.

The functional aspects are the object of much experimental work, but must be reconciled with structural aspects. One thing is to understand the functioning of an ecosystem in a mesocosm, or in a computer, over a short period (the period of the experiment, with a limited species pool) and another thing is to do it in the field. NASA tried to reconstruct an artificial ecosystem in a desert, selling the replication of terrestrial ecosystems in other planets, and failed (even on this planet). Things are more complicated than in our mesocosms or in our computers. The ecosystem approach, however, shows the way.

RE: The role of the Habitat Directive in halting biodiversity loss Marine is different!

Keith Hiscock, Marine Biological Association, UK

Summary: Indicators to assess marine biodiversity quality may not look that different to terrestrial but we need to understand that underlying ecological processes and the actions needed to protect marine biodiversity may be very different.

All of us have to suffer the pain of identifying a scientific interpretation and research to support policy ‘slogans’. In marine, ours is to produce “an ecologically coherent network of marine protected areas”. The history of that objective is convoluted but I suspect was over-influenced by terrestrial conservationists. Here I suggest some of the reasons why research supporting policy will be different for marine.

Marine is different because:

1. ‘Restoration’ and ‘Recovery’ almost always relies on natural processes (not on gardening and re-introduction);
2. Although extensive parts of the sea have been impacted by human activities, some (mostly open coast rocky) marine habitats are close to natural;
3. There is natural connectivity (for larvae, propagules, migratory species but also contaminants) via the water column between locations – and the water column is always there;
4. The ecological processes that shape and maintain marine biodiversity are very different to terrestrial;
5. Fluctuations in the abundance of a species may occur on decadal scales so that long-term decline or sudden ‘outbursts’ may be natural. (Perhaps there are terrestrial similarities, I don’t know.)
6. Our knowledge of what is where is, compared to terrestrial, very poor and, in the UK there are major areas of even inshore marine areas that we have not surveyed for habitats or biology;
7. Information on changes in abundance of a species is rarely as quantitative as for terrestrial species. Criteria such as for Red List categories can rarely be applied to marine species which are therefore recorded as ‘Data deficient’.

Understanding that marine is different begins to help us identify possible indicators of well-being. Ecological processes are on a scale that cannot be influenced by local management, so monitoring them is to help understand why a change has occurred. In that context, dispersal connectivity specifically between protected areas is a myth and I believe that an “ecologically coherent network” with regard to dispersal connectivity, cannot be achieved. Nevertheless, we need to understand recruitment processes and longevity of species much better.

We need threat criteria that have been ‘marinised’ to overcome the ‘data deficient’ dustbin and produce meaningful lists of rare, scarce, in decline or threatened with decline species and habitats. The criteria have been produced in the UK (to identify ‘Nationally Important Marine Features’) but insistence of compatibility with terrestrial criteria to identify UK Biodiversity Action Plan species and habitats has compromised that list for marine.

If we are to inform and influence policy makers and the public, we need to have measures that are understandable (but based on sound science) to convert into indicators. Perhaps as crude as habitat loss (extent of mudflats, hectares of saline lagoons, natural coastline without concrete defences, degree of dominance by non-native species, sensitive areas of seabed being trawled etc.) or areas of seabed that are fully protected, but also in terms of species richness at locations and the abundance of Nationally Important Marine Features. Having a full suite of representative sites is also important. I have on occasion seen an

objective of “maintain ecosystem function”. That is dangerous – the Baltic Sea ecosystem ‘functions’ but is highly impoverished (because of low salinity) compared to the Atlantic.

We need to maintain field expertise – then, after undertaking a survey, see whether the biologist comes back smiling. And we may even have to join our terrestrial colleagues in gardening to weed-out some non-native species from valued sites where they have an adverse effect.

RE: The role of the Habitat Directive in halting biodiversity loss Doing better for marine protection

Keith Hiscock, Marine Biological Association, UK

The posting from Ferdinando Boero neatly summarises why we need to identify marine habitat sensitivity and what activities those habitats are vulnerable to but also raises the issue of knowing where the habitats are.

The Habitats Directive was extremely crude in the suite of marine habitats that were listed, in part because there was no classification of marine habitats in the late 1980’s when the Directive was being drafted. There is such a classification now (under EUNIS) and we can identify sensitivity of each biotope within that classification to different pressures and human activities – a powerful tool (see www.marlin.ac.uk), but only if we know where those biotopes exist. I do that work – surveying, translating survey data into biotopes etc. and I believe that the estimate of mapping seabed biotopes (to the detail that is meaningful for conservation) in five years is impossible. The MESH (Mapping European Seabed Habitats) project worked hard to map seabed habitats in the NE Atlantic with partial success. What was not successful was the hope that remote (acoustic) survey techniques would identify physical and sometimes biological seabed types. It was worth a try but turned-out to be something of an ‘Emperors New Clothes’ exercise where the coloured maps looked great (to office based administrators) but to anyone who knew an area, were nonsense. So back to the drawing board and potentially enormous amounts of in situ (grab sampling, towed video, divers etc) survey work.

The Habitats Directive and OSPAR (The Convention on the Protection of the Marine Environment of the NE Atlantic) Annex V have forced otherwise reluctant governments to identify marine protected areas. In the UK, I believe that we have made something of a ‘silk purse out of a sow’s ear’ that is the Habitats Directive for marine. We have done that by identifying SACs that represent different variations of each Annex 1 habitat and we have identified those features within each site that are especially important (in terms of biodiversity conservation) and vulnerable to human activities. But we have done it where we know that a habitat exists at a location (not difficult for the Annex 1 Habitats but very difficult for fine scale types). There are large parts of the inshore areas of the UK that have not been adequately surveyed.

We have moved-on enormously in our ability to identify what is threatened in the marine environment and how to structure the information we have in a way that, with political will, can protect marine biodiversity. Some countries (the UK’s Marine Bill which applies to England and Wales is nearly through Parliament) have identified measures to protect marine biodiversity in a much more informed way than in 1991 when the Habitats Directive was launched. It is long past the time to put a line under the SACs series and to take new action based on our much better knowledge of the sensitivity of marine species and habitats, the types of habitats that need protecting and our ever-improving knowledge of where they occur to do better than the Habitats Directive.

Social-ecological systems for transdisciplinary biodiversity research

Diana Hummel, Institute for Social-Ecological Research (ISOE), Germany

Summary: This contribution argues for a transdisciplinary approach to biodiversity research, based on a specific perspective of social-ecological systems (SES).

Biodiversity is not only a result of biogeochemical dynamics, but also of human action. E.g. the relatively high occurrence of common beech, *Fagus sylvestris*, in the deciduous forests of Central Europe is directly linked to the land-use activities of settlers from the Neolithic era onwards. But up to now research for setting and monitoring biodiversity targets is conceptualized mainly in the ways of natural science.

Biodiversity management has problems to reach the defined targets because socio-economic action and ecological effects are closely intertwined. These interactions, and the uncertain knowledge base, complicate the assessment of the requirements for practical action. Given this hybrid problem structure, new research issues emerge in biodiversity science, requiring a transdisciplinary research concept that supports an integrated, problem-oriented understanding of the subject.

In the last decade Holling and other authors established the concept of social-ecological systems (SES) which offers an adequate conceptual framework for analyzing biodiversity dynamics including its social side, for identifying biodiversity targets as well as for developing biodiversity management strategies. According to the SES approach, ecosystem's responses to societal utilization of natural resources and the reciprocal response of people to changes in ecosystems constitute coupled dynamic systems. In order to manage biodiversity one has to understand the combined functioning of the social-ecological system.

For a better understanding of biodiversity dynamics and management, it is useful to focus on supply systems developed by societies to satisfy the basic needs of their population. These systems provide food, water, or energy; they are based on ecosystems and influence biodiversity via land-use. Supply systems are regulated by societies and depend at the same time on natural conditions and are affected by their variability. Given this perspective, the connection between natural resources and their utilization comes to the fore (cf. Hummel et al. 2008). Natural resources and their users can be regarded as the major components in such a supply system (being a specialization of SES). In opposition to the conventional land-use approach different user groups (peasants/foresters, industrial producers/utilities and consumers) are in the focus of research; their relations are understood to be an integral part of supply systems. Moreover, processes of resource utilization are determined in particular by knowledge forms (scientific and every-day knowledge), institutional frameworks (e.g. legal conditions), social practices and technology. These factors specify how biodiversity is changing, and they determine the success and options of biodiversity management as well as its adaptability, vulnerability and scope.

RE: Social-ecological systems for transdisciplinary biodiversity research

Vladimir Vershinin - Institute of Plant and Animal Ecology, Russia

For a better understanding of biodiversity dynamics and management we surely need to use both traditional and modern methods. Traditional means morphology, cytogenetic, cariology, albumine electrophoresis, immunological test e.t.c. Modern methods means PCR, DNA sequencing, and others. There is a great deal to be gained by integrating databases and sharing knowledge.

For a synthesis of modern and traditional methods we need to remove gaps between knowledge and understanding before we can increase the complexity of investigations. I agree with Diana Hummel that biodiversity needs a transdisciplinary research concept. In the field of ecological science the relationship between biodiversity and ecosystem functioning

(functional ecology) has emerged as a major scientific issue (Loreau, 2000). Researcher's realization within the framework of the concept of functional groups and functional diversity seems to now be perspective (MacGillivray et al., 1995; Lavorel et al., 1997; Hulot et al., 2000). The underestimation of the role that biota play in the process of regulation and substances transformation that forms geochemical parameters of the environment (Vernadsky, 2001) is dangerous under the effect of fast global changes of the biosphere (Ostroumov, 2005).

It is impossible to use any common law to describe interconnections between biodiversity or efficiency, by a transforming degree and stability – variability depends on environmental “context” (Cardinale et al., 2000). So we need investigations for various types of a landscape. Environmental fragmentation can lead to the appearance of new interspecies competitive or mutual relations (Dale, 2000). The anthropogenic transformations of a landscape can lead to serious biodiversity reductions and decreasing of species number as a result of certain loss of landscape elements (Shealagh et al., 2000).

Ecosystem conservation is impossible without preservation of species diversity, because only concrete species, forming biotic and abiotic relationships determine ecosystem functioning. Hence, biodiversity is the main parameter of the biosphere's state and the ecosystems composing it (Alimov, 2006).

The increase of ecosystem biodiversity due to new species invasion is a natural process that is accelerated as a result of anthropogenic influences. In many cases invasive species do not influence the main ecosystem balance and function, but sometimes invasive species can essentially change the functional ecosystem characteristic. Thus, the appearance of new species in an ecosystem is capable of completely reconstructing food circuits or can result in the creation of new circuits and chains (Golubkov, 2000). The study of invasive species ecology allows us to determine the important factors and dependencies between a variety of community resources and the width of a niche and probability of invasion success (Byers, Noonburg, 2003). Both the increase and the decrease of biodiversity can induce functional changes in a community and influence its equilibrium. Parasites play a very important role in the functioning and maintenance of ecosystem stability. Parasite complexes can seriously impact on morphogenesis processes (Ruth, 1987; Johnson et al., 1999, Glanz, 1999), and also mediate natural selection processes that seriously influence the genetic diversity of a population (Mitchellet al., 2005).

The morphogenesis processes are a very important link between functional biology and evolution (Gilberts et al., 1997). So, ontogenesis stability investigation allows us to control environmental stability and can help in understanding the mechanisms of morphological evolution (Cherdantsev, 2003). A physiological approach in functional ecology of populations allows us to explain adaptability efficiency under the effect of environmental destabilization (McCoy, Harris, 2003). Thus, an integrative approach using modern technology and methods to investigate biodiversity gives the possibility to leave traditional phenomenology for understanding biological meanings and to reach some prognostic conclusions.

As N.V. Timofeev-Resovsky stated – we have a problem of adjustment of a correct exchange of substances between biosphere and human society on a planetary scale. The decision of these problems is possible only under the condition of development of theoretical biology (Timofeev-Resovsky, 2009). The same opinion was argued by Ferdinando Boero - we need more theoretical research – that's the way we need to solve the problems.

That's why our bullet point is to unite information about all hierarchical levels of biodiversity from molecular up to the biosphere. This will help us to develop a new point of view on the evolution process and create a more balanced system of biodiversity conservation.



Session III: Conflicts between existing and potential targets.

What are the communication needs to ensure messages get across to decision makers and the wider public?

Peter Bos, Ministry of Agriculture, Nature and Food Quality of the Netherlands

An active position of researchers with regard to policy processes they intend to serve is likely to improve the relevance and outreach of research projects.

The topic of the EPBRS meeting is well chosen: how research can best support policy is a longstanding and fundamental issue and so far not always satisfactorily resolved. Moreover, it is a relevant question at a time that the international biodiversity community is trying to boost the policy-science interface by looking into the options for a new interface, the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES). Finding 4.1. of the IPBES Gap Analysis sums up the problem very clearly when it says "... decisions taken are not necessarily informed by the best available knowledge".

Undoubtedly there is still much scope for researchers in improving the way they bring their results across. Policy makers are not really interested, nor do they have the time, to read a 200-page report. They seldom go beyond the "executive summary" and particularly look out for the "recommendations for policy makers". For a research report to be effective those sections therefore have to be really good!

What else can be done to improve the effectiveness of researchers as policy advisors?

First of all, there is scope for a more active approach which includes serious efforts to understand and accept how policy processes and decision making work – in different fields, on different scales and in different types of organisation. Speaking the same language is a crucial condition for bringing key information across. This will make the researcher a much more interesting partner for the policy-maker. And it will encourage the latter to make a bigger effort to formulate what he needs and particularly also how and when he wants it delivered.

A similar active position with regards to NGO's is desirable. NGO's are often very skilled in communicating messages to policy makers and the public at large, using the media and the political arena effectively. Therefore they are natural partners in communicating the outcomes of research in an understandable, relevant way.

Getting involved in public debate is another way to get important messages across. Fortunately there are many good examples of scientists who take up the challenge of explaining in public, in the media or otherwise, their views and findings. No better way to influence public and political opinion than a knowledgeable and reliable professor expressing his views in a major television news programme.

With regards to the implementation of biodiversity goals, more emphasis on research on the relationship between ecology and society would be welcome. Traditionally much research focuses on species, but the question is whether more knowledge of certain species and their habits is really making a difference in dealing with today's major biodiversity challenges. In order to mobilise public and political support for far-reaching policy measures it is crucial to underpin and communicate the fundamental links between ecology and economy better. A stronger involvement of the scientific community in this challenge, and also from other disciplines such as economists, is required.

Is biodiversity the basis for ecosystem services?

Christian Prip, United Nations University, Institute of Advanced Studies

This contribution highlights the need to get biodiversity higher up on the political agenda and that biodiversity conservation may require different approaches in different parts of the world.

This may sound like a politically incorrect question. In recent years, and especially after the release of the Millennium Ecosystem Assessment, not many seem to question that biodiversity underpins ecosystem services. On the contrary, this underpinning is being highlighted as the primary reason for conserving biodiversity in a number of policy statements including by G8 Heads of State. The rationale is obvious: By arguing that biodiversity is a prerequisite for ecosystem services and thereby for human well-being and eradication of poverty, a strong incentive for biodiversity conservation has been created which did not exist before when conservation was often perceived as impeding development.

The connection between biodiversity and ecosystem services is apparently so strong that texts describing the issue often use the terms “ecosystems” and “biodiversity” randomly and synonymously. “Ecosystem services provide basic human needs such as...” could further down in the text be biodiversity providing these needs, or could be ecosystems and biodiversity providing. I don’t have a background in natural science and therefore I am not the right person to judge the science behind the issue. On this, I am part of the general public who needs to be convinced about the biodiversity/ecosystem services connection. And I am not fully convinced. Or in other words: It seems to me that the question is more nuanced than often presented.

To a large extent the connection between ecosystem services and biodiversity seems undeniable. You don’t need to be a biologist or agronomist to understand how important the diversity of bees and other pollinators are for agriculture; or the importance of genetic diversity for plant breeding. But when it comes to another biodiversity component of concern to many people, endangered species, the connection to ecosystem services seems less obvious. (Unless we label the value that biodiversity has in itself for most people as a “cultural service” which to me seems a bit artificial). Also, it seems like the link is not so obvious in our developed part of the world than in developing countries where people rely more directly on ecosystem services and are often unable to substitute these with goods and services they buy. A question I have often heard is: If biodiversity is so important to development, how come Western Europe has destroyed so much of its biodiversity and has become so rich at the same time?

We need clear and strong messages without too many nuances to get biodiversity higher up on the political agenda. The link between biodiversity and human well-being is a powerful one, and I am not arguing that we should not make use of it. But we need to be careful and not oversell this approach if there are still big gaps in our knowledge. We risk a serious back clash if our statements are scientifically inaccurate. We should state more clearly that conservation of biodiversity may require different approaches in different parts of the world. While an ecosystem services approach may be the best for developing countries, an approach building primarily on non-utilitarian values of biodiversity may still be the preferred one for Europe. Still, we should do more research in Europe about the connection between biodiversity and ecosystem services, and fortunately this is already on the EU research agenda.

RE: Is biodiversity the basis for ecosystem services?

Renat Perelet, Russian Academy of Sciences, Moscow, Russia

This subject can be viewed from different angles:

Firstly, biodiversity is part and parcel of natural capital. Biodiversity is depleting largely because there is mainly no real market (and market value) for it. Among the three kinds of capital - produce (all human made things around us that are easily marketed that, according to the World Bank, constitute not more than 15-18% of the overall national/global wealth), social/human capital (that is growing in value and price), and living natural capital, the latter has the lowest share in the world market and trade. For example, pharmaceutical and perfume making Trans National Corporations (TNC's) reap huge profits paying peanuts to get organic raw materials from developing countries that later get medicine at an extortionate price. Even in Europe, medical and aromatic plants are cheap. They are usually not items to be handled under CITES. That is why they are becoming scarce.

Secondly, showing a real high value of ecosystem goods and services in monetary terms is what is lacking, but is necessary. Hence environmental valuation, as well as economic and environmental accounting systems (e.g. ISEEA suggested by UNEP in 1993 and updated in 2000). In addition, attempts have been made to stress that GDP is an indicator of economic (both good and bad) dynamics but not of human welfare, which is basically dependent on ecosystem goods and services and biodiversity. When the NPA manager goes to the government financial officer he/she should talk to him/her in the same language of money (as it is the only common denominator government understands) and persuade the minister of finance to allot the money for the nature reserve providing arguments about a high monetary value of (rare) species, even if s/he thinks to him/herself that they also have a high scientific or scenic or existence value. If we changed the monetary system to, say, biomass or biodiversity indicators (there are proponents of such a change), then things would be different. So, we should work within the system we have. Land plots should be priced with the due account of biodiversity value they carry so that they can compete with the use of lands for cottage development.

Thirdly, UNEP, CBD, UN ECE, IUCN, WWF and other organisations have recently decided to study the subject of international payments for ecosystem services building upon the experience available up to date⁹ In addition, the TEEB project¹⁰ should look into this biodiversity value issue and work out specific numbers for it.

Fourthly, I suggested at several scientific conferences that a protocol on biodiversity similar to the Kyoto protocol could be a useful way to conserve and use ecosystem services in a sustainable way. Incidentally, I am at variance with the MA report by arguing that one should separate ecosystem goods (that are movable and may participate in the world trade) from ecosystem services (that are usually immovable and can hardly be separated from the place ecosystems are located).

RE: Is biodiversity the basis for ecosystem services?

Ferdinando Boero, University of Salento, Italy

The questions posed by Christian Prip are crucial. The goods and services issue is anthropocentric and risky. Historically we have progressed from hunter gatherers to agriculture. No terrestrial natural population can be exploited industrially (besides some forests) everything must be cultivated and reared. Fake ecosystems, sustained by strong injections of fertilizers and pesticides cannot be sustained.

In the oceans we are still hunters and gatherers. We draw resources from natural populations (with fisheries). But our oceanic ecosystems are also collapsing. We are shifting from a fish to a jellyfish ocean and we are passing to aquaculture (but we rear carnivorous species that we feed with smaller fish taken from natural populations). If we continue down

⁹ <http://www.unep.ch/etb/events/2006-PESTD12-13Sep.php>
http://www.unece.org/env/water/meetings/payment_ecosystems/brochure.pdf
http://www.unece.org/env/water/meetings/payment_ecosystems/seminar.htm#back

¹⁰ TEEB project - http://www.eurekalert.org/pub_releases/2008-05/haog-teo052908.php

this path the world will be ugly and boring, like a one-species only agricultural ecosystem compared with a tropical forest. Is this the world we want to live in? Surely a world like that will not sustain us anyway? These systems do not work without external inputs (there are already people injecting iron in the ocean to enhance its functioning).

We have concentrated too much on cultivation and have forgotten about protection. Protection is to become our first concern, because we cultivated too much. We have to limit our growth. Biodiversity erosion is a signal that we are going over the limit.

RE: Is biodiversity the basis for ecosystem services?

Pedro Herrera, Gama S.L. Valladolid, Spain

An obvious point about the answer to this question flows directly from our concept of biodiversity. Assuming that biodiversity and ecological diversity are not exactly the same question, our tools to measure diversity implies always measuring the information content of the ecosystems. So, the real strong link is between biodiversity and information, we could simplify this by saying that biodiversity is the way ecosystems accumulate information. So, we need every piece of this intelligence to ensure that services people need now, and will need in the future, continue to exist. Losing biodiversity is an act of arson, destroying the most fabulous technical library we have ever seen. Moreover, if self evolution of some ecosystems implies local loss of biodiversity, how can this be acceptable from our point of view and how can we find it useful to fight biodiversity loss against “natural” processes?

RE: Is biodiversity the basis for ecosystem services?

Biodiversity is largely redundant

Rasmus Ejrnæs, Department of wildlife ecology and biodiversity, NERI, Aarhus University

Summary: Biodiversity is largely redundant, and only a minor fraction of the ecological space is servicing humans.

Thanks to Christian Prip for posing a highly relevant question. I regularly question that our prime concern about biodiversity loss should be linked to loss of ecosystem services. And regularly feel politically incorrect, as the broad consensus seems to be that we preserve biodiversity in order to maintain ecosystem services.

I am not a specialist in developing countries, but I'd like to draw on examples from biodiversity loss in Denmark and its relation to ecosystem goods and services and use this to challenge the view that biodiversity is linked to services to humans. First I need to make a clarification: when I refer to ecosystem services, I mean services to humans, services that may be calculated in economic terms. If ecosystem services include services to other species, the argument becomes circular and no longer serves its purpose, namely to explain why humans should conserve biodiversity.

The first example comes from forests. Forests are the ecosystem hosting most species and most red-listed species in Denmark. A disproportionately large fraction of the red-listed species depend on the presence of ancient broadleaved trees and coarse woody debris (dead wood), but due to intensive forestry this habitat is largely lacking. Furthermore woodland glades are lost due to drainage, planting and cultivation of fodder crops for deer game. In the case of the forests it may be claimed that the ecosystem has largely been planned according to optimal harvesting principles. With respect to biodiversity the past 100 years has been a catastrophe, but with regard to ecosystem services there are no obvious signs of degradation or over-exploitation. The variety of wild species thriving in woodland glades, small wetlands, ancient trees and coarse woody debris are not enhancing the production of timber and wood fuels - not even the game animals, berries and mushrooms collected by forest visitors. On the

contrary, it is precisely the harvesting of trees long before maturity and the planting of trees in glades that reduces forest biodiversity.

The second example comes from (semi-)natural open grassland, heathland, fen and meadow. Next to forests, they hold the largest fraction of threatened terrestrial biodiversity in Denmark. The most obvious threats to biodiversity are eutrophication, drainage and abandonment (ceased grazing). Here it is agriculture, not forestry that optimises resource exploitation. In order to produce crops and meat in competitive quantities, the grazing areas are either “improved” with nutrients and sowing of high yielding grass-clover mixtures, or they are abandoned and left for natural succession with high inputs of nutrient polluted rain water and drain water. It may be claimed that these improved agricultural ecosystems are not sustainable because they depend on high external inputs. But where I live, we practice organic farming with leguminous N-fixation, fast crop rotation, goats and cows, and it is no big task to maintain an improved soil fertility that keeps away a variety of stress-tolerant plants, butterflies, grass hoppers, wild bees etc.

I attended a conference in Ghent in 2008 on Ecological Restoration. It was interesting that plenary lectures repeatedly stressed the importance of biodiversity for ecosystem functioning, but when we went on the field trips, several excursions went to places where the top soil had been completely removed in order to reach a soil sufficiently infertile as to allow the development of semi-natural habitats such as fens, heathland or grassland. In other words, the destruction of ecosystem services was needed in order to restore natural habitat.

I admit that there are examples where biodiversity seems to coincide with ecosystem services, but I am not convinced that this is anything more than coincidence. In most cases human needs are related to such a small part of the ecological space that an optimal harvesting strategy for humans will lead to biodiversity loss.

If this is true, then we should seriously start considering if and why biodiversity is important for us to conserve. Personally I’d go for a rational-spiritual motivation. The rational part is related to the fact that we humans are ourselves the result of an unpredictable evolution, just as the rest of biodiversity. There was simply no way to predict, 63 million years ago, when something wiped out terrestrial dinosaurs, that mammals were such a brilliant idea. The spiritual part is related to the experience that you do not want to destroy and impoverish what you are part of yourself. It is a moral obligation and it can never be replaced by economic calculations.

As a research policy post script: I think we should do more research into biodiversity per se, and less in biodiversity for human services, because the latter is more a political wish and hope than a sound scientific hypothesis...

RE: Is biodiversity the basis for ecosystem services?

Felix Rauschmayer, Helmholtz-Centre for Environmental Research UFZ

Christian Prip was concerned by the lack of evidence between biodiversity and ecosystem goods and services (ESS). I am also (and even more) concerned by the lack of generalised evidence between ESS and human well-being. Because it is the latter issue that is the aim of politics (even if we use numbers such as GDP or other monetary values as bad indicators for human well-being (cp. <http://www.beyond-gdp.eu/>).

Of course, there is plenty of anecdotal and common sense evidence in which one specific ESS is necessary for human well-being. But neither the MA nor subsequent discussions really focussed (at least, to my knowledge - please indicate the contrary, I’d be pleased to know) on gaining a common understanding of what we mean by human well-being, and how ESS systematically link to it. This could then enable us to distinguish systematically between different uses of ESS: what actual use of ESS is really necessary to maintain human well-being (depending on natural and social environments) now and in the future and what could be replaced by social or man-made capital (having ecological rucksacks as well).

To sum up: Indicators for biodiversity help a lot more to contribute to sustainable human well-being and to influence policy, if we know the link between: biodiversity and their indicators; biodiversity indicators and ESS; ESS and human well-being.

RE: Is biodiversity the basis for ecosystem services?

Riccardo Simoncini, University of Florence, Economic Sciences Department

Summary: This contribution outlines the importance of considering, beside the economic value, the “public good” character of many ecosystem goods and services in order to achieve more effective policy for biodiversity conservation.

The approach of linking biodiversity conservation to ecosystem functioning and delivering of environmental goods and services which satisfy human needs has the advantage to cross the bridge between the disciplines of natural and socio-economic sciences by facilitating the understanding the value of biodiversity conservation for human welfare. Following this reasoning many economic valuations of ecosystems goods and services, such as the one presented by Costanza et al. (1997), have been proposed to assess the value of conserving biodiversity. However despite the great efforts spent by the scientific community in showing the high economic value resulting from conserving biodiversity, still there is little success in terms of implementation of effective policy actions leading to halt the loss of biodiversity worldwide. This depends on many factors, however, spatial scales, temporal dimensions and the character of public good of many ecosystems goods and services play an important role in the loss of biodiversity.

For what regards the spatial dimensions, policy decisions taken at different hierarchical scale such as those taken at regional, national and international levels have impacts on the ecosystem management at local level (e.g. subsidies to production of EU Common Agricultural Policy (CAP) in the 70's and 80s as well as global market demand). But also individual farmer decisions such as those related to soil erosion and water run-off control can have both an evident importance at the level of single field and at the level of water catchments because of transported sediments polluting water courses. The temporal dimension of the pressures exerted by socio-economic activities very often show positive and/or negative impacts on the supply of environmental goods and services by ecosystems with a time lag. This is for instance the case when the impact of the conversion of a natural habitat to agricultural use, or the loss of biodiversity because of excessive use of pesticides, may not be detected immediately but showing the seriousness of welfare loss only after some years.

These facts have obvious consequences on biodiversity conservation and create problems of equity in distributing costs and benefits related to the supply of ecosystem goods and services, often resulting in externalities in some cases of intergenerational character. The presence of externalities resulting from the spatial and time aspects described above can often depend, directly or indirectly, on the public/private character of ecosystems goods and services. Ecosystems goods and services such as food and fibre, fresh water, ornamental resources, wood, recreation opportunities, etc. are private goods. These are goods from which an individual can have a direct utility. Private goods can be easily exchanged through markets and treated as commodities. On the contrary other ecosystems goods and services such as cultural and historical identity, habitats for wild species, air and water purification, climate regulation, erosion control, etc., are public goods. These are goods that have the characteristics of non-excludability and non-rivalry in consumption. These kinds of goods cannot be exchanged automatically through markets alone given the impossibility to exclude non-buyers to exploit benefits from them (or, in the case of loss, to exclude the general public to sustain the costs), so often resulting in externalities.

From the acknowledgment of the failure of having decision makers, including business entrepreneurs, to take into account the economic value of biodiversity in land use and development policies, it should be clear that we need to look more closely at what are the

governance factors and processes that can enhance or impair ecosystem services and conservation of biodiversity. For instance the characterisation of ecosystem goods and services in public/private goods and their more or less appropriateness to be exchanged by markets could be useful to explore:

1. If objectives of policy decisions and the management of natural resources are oriented towards the delivering of private or public goods; and
2. If policy instruments implemented are coherent with the private/public character of the goods to be delivered and contribute effectively and efficiently to the achievement of the policy goal.

RE: Is biodiversity the basis for ecosystem services?

Martin Sharman, European Commission, Brussels

N.B. The views expressed in this comment are purely my own and may not in any circumstances be regarded as a position of the European Commission.

I agree with Rasmus Ejrnaes that anthropocentric reasons for concern about biodiversity loss are distasteful and ethically dubious. I also agree that we can have no idea which of today's organisms will have left descendants in a few tens of millions of years. There are moral reasons to cherish other forms of life than our own. Of course there are. But unfortunately for those of us with moral concerns for life on Earth, ecosystem conversion is good for business, so biodiversity loss is good for business.

A burden of 6.7 billion humans would leave little space for compassion for other species, even with the most benign of economic models. Our global model of competing economies that depend on growth requires that we consume more and faster with each passing day. Under these circumstances morality and evolutionary potential are feeble arguments that have not prevented, and will not prevent, the continuing wholesale destruction of ecosystems whether in oceans, rainforests or elsewhere. Ethical concern for some endemic orchid or arthropod may conceivably be enough to help its survival in Denmark, but not to prevent its cousin in some distant land being bulldozed to make space for products to be marketed in Europe. There is, frankly, little hope of convincing major commercial companies, on ethical grounds, to stop doing what makes them rich. There is marginally more hope if we can show that the ecosystem they are about to eradicate provides a greater likelihood of income than whatever they intend to replace it with.

I also agree with Rasmus that our argument for preserving biodiversity just to maintain ecosystem services is weak. What little evidence we have suggests that the trophic webs and social dependencies in ecosystems exhibit characteristics of small-world and scale-free networks. This would imply that most inter-specific connections are not critical to the ecosystem, a conclusion that is supported by many empirical and unintended experiments around the world. In other words, diversity in itself is often not necessary. We can continue to enjoy services from the ecosystem at the same time as we simplify it. But it also implies that a few species in any given ecosystem are maintaining structurally critical connections with other species. The loss of such a species might have noticeable effects on ecosystem services. We're not often in a position to say beforehand which of the species in an ecosystem occupy these network hubs, so the precautionary approach would urge caution. Following this logic, then, it is not so much that biodiversity provides ecosystem services, but that ecosystem services may help to preserve biodiversity from the human juggernaut.

Felix Rauschmayer points out that there is not much research to quantify what ecosystem services contribute to human well-being. Continental rain is an ecosystem service, as is oxygen and atmospheric nitrogen. (If you think atmospheric nitrogen is inert and biologically unimportant, consider that thanks to the Haber process, most of the 3% of your body mass that is made up of nitrogen was recently artificial fertilizer, and shortly before that, a gas in the atmosphere. And it got there thanks to denitrifying bacteria.) How do we quantify the contribution of any of these things to human well-being? Ecosystem services are by far

the strongest argument we have to try to persuade those who have the power – which is to say, those who own the bulldozers – or those who legislate what the bulldozers may or may not do.

It need hardly be pointed out that research into biodiversity per se is entirely futile if, while we are busy taking measurements, the bulldozer is growling up the hill towards us. Research into the living world is vitally important, I agree. But equally importantly, we have urgently to understand how humans interact with and benefit from the nature to which we belong – in that way, perhaps, we can find out how to preserve the object of our study at least long enough to complete the research.

This is why targets should in some way incorporate aspects of the services provided by ecosystems. In an earlier post I had suggested ‘the wild populations of every species of non-human primates are growing, and at a rate faster than the human population’ because for such a thing to happen, the forests in which they live would have to be restored and defragmented. This in turn would mean that human demand on the forest ecosystems would have to be reduced below the level at which the forest could regenerate. This would require that the ecosystem services would have to be properly understood and accounted for, and placed in balance with human needs. A similar argument holds for the proposed coral reef target.

RE: Is biodiversity the basis for ecosystem services?

Robert Scholes, CSIR Natural Resources and the Environment, South Africa

Part of the problem is the tendency of the community to rush from one extreme position to another: all that matters is biodiversity for biodiversity’s sake to all that matters is the benefits humans derive from biodiversity. A careful reading of the MA literature (especially its conceptual framework document) will show that ‘utilitarian’ concepts, such as ecosystem services, were never proposed as replacements for the ‘intrinsic value’ concepts that have implicitly guided biodiversity conservation efforts to date, but as a supplement. The MA argument for ecosystem services does not reject spiritually or ethically-based positions, it simply says that they are not amenable to a MA-style assessment. By the same measure they don’t lend themselves to indicator development either. The ecosystem services argument has provided additional traction in some quarters- such as in relation to the diversity verses development (false) debate. It also helps to move the biodiversity protection strategy out of the protected area and into the living, working environment where most of the issues are played out. One of the ecosystem services we often neglect is the service of providing habitat for biodiversity - if this is considered, then several of the paradoxes raised by Rasmus Ejrnaes are resolved. Ecosystem services are often in conflict with one another.

As an aside to Felix Rauschmayer, the MA did put a lot of effort into defining a common understanding of what constitutes human wellbeing - again, look at the Conceptual Framework book of 2004. They opted for a broad and progressive view: it includes income-based measures, but goes far beyond them to embrace health, security, good community relations and issues such as freedom and choice. The MA acknowledged its failure to make a clear link between ecosystem services and the components of wellbeing. Partly this is because of careless conceptualisation (for instance, a large part of human wellbeing is derived from other sources), but also because the data on ecosystem services were incompatible in scale and detail with the data on wellbeing.

But in relation to the real thrust of the question, we are the self-created victims of a lot of semantic imprecision. When it suits us, we use ‘biodiversity’ to mean ‘any living thing’. By this definition, of course ecosystem services depend on biodiversity; but in reality the services usually depend on a very small subset of ‘all living things’ and a high degree of substitutability is often possible - either between species, or even with non-living sources. The case for diversity per se as being important is much less well-established. The evidence, such as it is (much is reviewed in the MA, and there has been a lot of subsequent work), is that there IS a positive relation between diversity and production-based services, but it saturates at fairly low levels (<10) and there is high redundancy within functional types. There is a

stronger theoretical case for biodiversity being important in assuring provisioning and regulating service flows under fluctuating or changing environments, but less empirical work has been done on this aspect. The case for biodiversity (at species level and landscape level) being directly related to certain cultural services (spiritual, recreational, aesthetic, educational, scientific) is clear.

RE: Is biodiversity the basis for ecosystem services?

Monetary numbers do not necessarily express human needs

Felix Rauschmayer, UFZ - Helmholtz-Centre for Environmental Research

Riccardo Simoncini just made a link between the satisfaction on human needs and monetary evaluation such as the famous one undertaken by Constanza et al (1997) - which is methodically very dubious, but politically rather successful. Monetary evaluations measure monetary expressions of preferences, which are fine, but not necessarily expressions of human needs!

There are several issues related to this and I'll deal with three of them:

1. Unfair distribution of monetary power
TEEB (The economics of ecosystems and biodiversity - www.teebweb.org) tries to address the issue of the "GDP of the poor" by claiming again and again that 'one dollar is not one dollar', at least not, if you have some basic concept of fairness. Europeans can spend a lot more on specific issues than most other inhabitants of the world. And in the future humans won't have money at all.
2. Implicit assumption of marginal decisions
With money, I usually buy private goods and services that can be exchanged, substituted, reproduced etc. But biodiversity and ecosystem services very often do not belong to these types of commodities. Market or market-like decisions (based on monetary valuation) might not be the appropriate decision structure - it is a political decision how to treat these.
3. Lack of distinction between monetary expressions of preferences and human needs
While sustainable development talks about needs, markets talk about money. When we talk about money, we mostly talk about preferences ('do I prefer a red race bike or a black city bike?'), not about human needs ('Why do I need a bike? subsistence? community? autonomy?'). The link between monetary expressions of preferences and human needs might be quite weak - at least for the majority of money exchanged (on stock markets, for car insurances, even in super markets). Have a look at Constanza et al. 2007 or Cruz et al. 2009.

This is why I mentioned in my last contribution that the link between Ecosystem services and human well-being (conceptualised rather through needs than through money) needs more work.

New strategies are needed

Klement Tockner and Hans-Peter Grossart, Leibniz Institute for Freshwater Ecology and Inland Fisheries, Germany

We agree that the 2010-target is a highly valuable commitment that has raised major public awareness on the global biodiversity crisis that we actually face and that will threaten nature and humans. However, the 2010-target was very ambiguous and hence it must have been clear from the beginning that the 2010-target could not be achieved in the short time frame.

Firstly, we have very limited data that clearly show long-term biodiversity trends at global and regional scales. In a recent European analysis of freshwater biodiversity (from 165 catchments covering 7 mill km²) we could show that the number of fishes that disappeared depends on the scale. While only a few species disappeared at the continental scale, up to 50% of the former native species went extinct at the catchment scale, and more than 70% at the sub-catchment scale (e.g. Upper Rhone). On the other hand, the relative proportion of non-native species could be as high as 50%. Consequently, we often do not see a major loss in total species richness but a fundamental change in the community structure. Along sections of the Danube or the Rhine Rivers almost the entire benthic community could be composed of non-native species. What we see is a great “reshuffling” of biodiversity, and we have almost no idea how these “novel communities” will affect key ecosystem processes.

Secondly, biodiversity is probably decreasing faster than ever despite all conservation efforts such as the implementation of the Natura 2000 network, the WFD, the CBD, or the 2010-target. We can expect major time-lags between causes and effects of biodiversity loss (similar to demographic development or CO₂ increase). We fear that many conservation or restoration strategies simply do not work or achieve their goals because of delayed effects, nonlinear relationships, scale-effects, etc. For example, in a recent assessment of river restoration projects worldwide Margaret Palmer and co-authors have shown that only in a few cases restoration has led to a significant recovery of local diversity. In most cases no effect had been observed, or restoration even has led to a further decline in species richness. In a globally changing world, it is of major importance to fundamentally reconsider our conservation and restoration strategies. Additionally, we have to tack other aspects into consideration such as the evolutionary potential of an ecosystem, linking technological with natural processes, etc.

Thirdly, the 2010 target competes with other targets and directives implemented at national, EU, and global levels. For example, the attempt to reduce greenhouse gas emission has resulted in a boom of small hydropower plant construction and in an unprecedented conversion of land for bioenergy production, further threatening biodiversity (but with minimal or even negative effects on CO₂ production due to rebound effects). Similarly, there exist major plans for improving and expanding navigation canals and routes accelerating the spread of non-native species and biotic homogenizing. Today, we can already travel by boat from the Rhone to the Volga River without entering the sea, meaning that most of Europe is biologically already a “supercatchment”. Additionally, the boom in aquaculture (in 2009, 50% of the fish we consume is from aquaculture), may cause major threats to native communities. There are many other examples that highlight the competing interests and directives.

It is clear that the decline of biodiversity and the erosion of related ecosystem services is one of the biggest challenges on earth, similar to climate change, securing an energy supply, or feeding the growing world population. It is also clear that we will not be able to stop the decline in biodiversity globally, but we need clear guidelines for setting priorities (where, what, how, etc.?) - based on the best available science. From a limnologists perspective it seems to be clear that at the European scale the Mediterranean area deserves the highest priority. It has a high proportion of threatened and endemic species which at the same time experience the greatest pressures that will even increase in the future (water stress, fragmentation, invasion by non-native species, land-use degradation, etc.). Tight collaborations between scientists, the public, stakeholders and politicians are needed to cope

with the various competing interests and to develop innovative strategies for biodiversity conservation.

Here, we propose the following future challenges for biodiversity research:

- evaluate loss of biodiversity at different scales in relation to ecosystem functioning
- define relevant criteria to evaluate the impact of anthropogenic actions on biodiversity and ecosystem functioning
- develop new strategies to halt biodiversity loss even in a globally changing world

RE: New strategies are needed

François Bonhomme, University of Montpellier 2, France

I would like to react to the point made by Klement Tockner and Hans-Peter Grossart that the 2010 target conflicts with many other targets and directives at national, EU and global scales.

Yes, 3X yes, the basis of the problem I believe is that there is a built-in negative trade-off between what drives political decisions and what should be good for biodiversity : the only words that 99% of the decision-makers have in the mouth is: growth, please more growth, especially in those times where global economy slackens pace. Biodiversity and other concepts come second if and only if they can contribute to growth, so no matter what, there is a very strong push towards increasing the per capita ecological impact both in developed and not so developed countries. In the former countries because this economic growth is the only model which gives free space for political action, if we exclude totalitarianism, and no matter how, this translates at the end of the day into more transportation, more habitat fragmentation, more land use and more biodiversity loss. Even if cars are less polluting and houses better insulated, there are more cars and more people everywhere, and a global higher ecological imprint. In the later countries, don't blame them, this is because when you earn a handful of dollars per day and consume virtually nothing, you look for more...

I think we should reformulate the initial questions, not leaving the public opinion with the misleading impression that science may solve the problem, be it granted more money, but insisting on that this is a societal problem implicating fundamentally our ways of life and our demography. We should not be afraid to say it loud and clear. We should also impinge upon the socio-economical world to force them to include ecological impact in their models and ask how can we orientate economical/industrial growth to diminish its negative trade-offs

With such a pessimistic vision, it is still probably useful trying to alleviate the worst aspects of the aftermath: Can science contribute to identify in a rational way the targets we want to save at any price, given we realise that we'll never reach a steady state, and given the limited scope for action due to the lack of political will and the inevitable worsening of almost everything, starting with climate change? I insist on these two "given" points that, in my opinion, were a little bit missing in the whole debate...

RE: New strategies are needed

The social roots of biodiversity loss

Denis Ruyschaert, PanEco Foundation

Summary: This contribution highlights four dimensions of biodiversity loss: market oriented economy, governance-globalisation, local reality and action of conservation NGO sub-optimal action. Based on this, the paper provides types of studies needed to develop "strategies" to address biodiversity loss.

This contribution may reply to Klement Tockner and Hans-Peter Grossart's need to find "new strategies" to address biodiversity loss. It also replies to Christian Prip's keen observation "is biodiversity the basis for ecosystem services?" Christian noted that it is difficult to convince European politicians that "biodiversity provides many ecosystem services", as Europe is rich,

but has destroyed most of its biodiversity (the opposite of Africa, poor but still hold a lot of biodiversity).

There is an emerging societal agreement on the importance of biodiversity, especially for its more charismatic representatives, such as the Great Apes. These last 20 years, there was emerging a complete set of tools to save biodiversity: International conventions, national policies and laws, national and international environmental institutions, strong organized civil society organizations, keen public interest and even large funding available. Therefore, how can we understand this paradox that biodiversity loss continues, especially in the case of Great Apes, when there is global governance with all legal-political-governmental tools, clear actors to save biodiversity and a global society will to manage it sustainably?

To study this paradox, I focus on what is happening in a specific area, the Tripa peat swamp forest (a once pristine forest in Indonesia holding densities of orangutans listed as GRASP UNEP-UNESCO priority site) now being converted to oil palm plantations. The study analyzes what is happening for each stakeholder (Government, private companies, NGOs, local people...) at local, national and international levels (international forum). The study is for 4 years (2006-2010) to take into account dynamic factors.

Four reasons mutually reinforcing each other can explain most of the on-going destruction:

1. "Referential". While there is a global will to preserve biodiversity, the reality is that each national economy is "market" orientated. Therefore, if a choice between short term economic gain and long-term biodiversity preservation has to be made, the former is always taken.
2. "Governance and globalisation". Governance of global assets is in practice extremely difficult for reasons linked to information flow, establishment of networks and feeding these networks at different levels (local, national and international), effective participation of local public and state responsibility. Even when an agreement is found it does not necessarily last and is always an on-going process. On the contrary, destruction takes place only once and biodiversity is lost forever.
3. "Local reality". Societies that host the highest biodiversity are often in disintegration (social, economic, political) and alternative democratic models are often not yet working. Local populations are not well organized and some people are only interested in direct gains. Often, long-term alternative conservation models cannot address direct local needs.
4. "System of action". Conservation NGOs are often un-able to act efficiently and effectively to save biodiversity. Either they have internal contradictions (such as keeping good relationships with some government officials for other projects) or there are external contradictions for other organizations (need to link with other social, environmental actors to get more impact, but these actors have other interests). For those reasons, actions are too often sub-optimal and delayed, or even come too late.

It may be important/interesting to do more studies to analyze biodiversity loss in specific local sites or specific sectors (i.e. agriculture), and then understand what is happening horizontally (from the ground locally to the international level) and vertically (in time). This would provide valuable tools to:

1. Influence world politics and the media to get biodiversity higher up on the political agenda.
2. Improve the "Link" between local and global, and multi-level governance.
3. Address local reality in a dynamic manner.
4. Improve conservation action, which is too often sub-optimal.

In this contribution, there is no will to search "real linkages between biodiversity and ecosystem services" as Peter Bridgewater wrote. This approach is often highlighted, as it fits well in the "global discourses" of the market-oriented economy. But, in fact it may be worrying to focus too much on it. It is like saying that biodiversity could not exist by itself. And also, if the link is found to be too little in monetary terms, people/politics could argue that destruction can be compensated by other technological investment and preservation is not worthwhile. People should really appreciate biodiversity for itself, and re-instigate society as being a part of nature.

A Global approach to reach biodiversity targets

Sandra Luque, Cemagref - Institute for Agricultural and Environmental Engineering Research, France

Strong mechanisms still need to be developed to reach a North-South cooperation in tandem with international academic programs in conservation to reach and implement real biodiversity targets. Biodiversity is not the problem of a particular region but a Global problem of global concern.

Tropical forests mainly in Southeast Asia and Brazil are under threat from oil-palm growers. The livelihoods of local populations are also at risks with the loss as well of the native products that they grow (food biodiversity at risk). How can we come up with an opportunity to combine “sustainable” economic growth (based on interests from the North), to the needs for biodiversity conservation? This is just one example of the many you know so well.

Despite the many international mechanisms set up under the framework of the CBD 2010 target not much was achieved. The “Paris Declaration for biodiversity” (Paris Conference, January 2005), set up a compromise to reinforce the links between the North and South in order to work towards an improved protection for biodiversity. However, nothing was accomplished. Moreover, the message from funding agencies today is: “Biodiversity is not selling anymore”... Therefore many projects, networks and efforts that started under the CBD 2010 logo, will not see a logical continuation and support... Nevertheless, there are fundamental questions that still need to be answered but due to the failure of the CBD target we cannot get funding or support to continue work towards fundamental issues related to biodiversity loss and ecosystem integrity.

One of the fundamental problems was that governments did not set up a biodiversity research agenda similar to what happened in Climate Change and Ozone Depleting Substances, nor did the Science Foundation’s set up specific, globally coordinated programs to keep up with the globalization of science through the Internet. The failure is also, in part, our responsibility: as scientists, we did not reach policy makers in time. At least not in the same way that the climate change community did.

National and international support on monitoring and restoration activities is needed. Subsequently, long term data are needed to be able to develop appropriate conservation and management options and plan for changes within climate change scenarios. Free and open access to biodiversity data is today a reality (e.g. www.gbif.org), but much work needs to be done to fulfil the data portals with good quality data for countries where this is most needed.

In order to fulfil the biodiversity challenges that lie ahead, capacity-building opportunities need to be implemented, that encompass different levels, audiences and contexts, in particular within developing countries. The role of public beliefs, perceptions and attitudes on biodiversity loss needs to be considered in tandem with conflict management.

Focus on concrete measures in relation to policy implications and problems of implementation are another big challenge. Legislation in relation to natural resources in many parts of the world is quite advanced, but problems remain on the implementation. In the first place, an international code of ethics in particular for logging companies, for mining companies and for plantation companies operating around the world is needed.

No target will be achieved if we do not consider a global approach to the problem and a worldwide compromise.

Contribution of the policy committee of the society for conservation biology- Europe section (SCB-ES)

Nuria Selva, Institute of Nature Conservation, Poland

This contribution outlines 3 key issues to be considered in a post 2010 target: conservation of roadless areas in Europe; research on common species as sub-targets/indicators; and how to overcome potential conflicts between preservation of biodiversity and sustainable development.

Roadless areas as a post-2010 conservation target in Europe (Selva et al., in press):
With increasing road encroachment, habitat fragmentation by transport infrastructures, and consequential secondary development and facilitation of human access, has become a serious threat for European biodiversity. The negative effects of roads on populations, species and ecosystems are manifold and represent a main driver of biodiversity loss. Contrastingly, areas with no roads or low-traffic (“roadless areas”) represent relatively undisturbed natural habitats and functioning ecosystems. They provide many benefits for biodiversity and human societies (e.g., landscape connectivity, barriers against pests and invasions, ecosystem services). Roadless areas gain special relevance in the context of climate change because of their higher resilience and buffering capacity.

An analysis of European legal instruments, ranging from national laws to conventions and European Union directives, illustrates that, although most laws aimed at protecting targets which are inherent to fragmentation like connectivity, ecosystem processes or integrity, roadless areas are widely neglected. Given the numerous benefits they provide, we propose that the few remaining roadless areas in Europe should be an important focus of conservation efforts. An inventory of these areas should be of top priority. We also urge for the proper integration of roadless areas into transport policies; when possible the design of new routes should strongly avoid dissecting them. Finally, roadless areas may deserve to be included in the Habitats Directive as a new target or site category. This would represent a concrete step towards the strengthening and adaptation of the Natura 2000 network to climate change.

More attention to common species as sub-targets/indicators (Gatson and Fuller, 2007):
Not only threatened species should be the focus of conservation priorities. Common species shape the world and are fundamental to the structure and functioning of ecosystems. Many rare species were once common (e.g. Atlantic cod, *Gadus morhua*). There is a need to act in advance and pay increased conservation attention to common species (identify, monitor and alleviate significant depletion events).

Conflict between preservation of biodiversity and sustainable development (Cohn, 2008; Curry, 2009; Tellaria 2009):

The promotion of the use of renewable energy, without appropriate consideration of biodiversity issues, is illustrative: wind farms impact on bat and bird populations; hydroelectric development impact on river ecosystems; solar farms consume large amounts of good habitat; production of biomass for the energy sector leads to additional intensification in rural landscapes (loss of high nature value elements, impacts on species rich grassland) as well as in forest ecosystems (increase in forest biomass production through drainage, fertilization and introduction of alien tree species represent areas of conflict).

Conflicts between strategies to protect human health and the preservation of biodiversity and ecosystem function (Tella, 2009; Hudson et al., 2006):

Parasites, pathogens and decomposers represent key elements of any healthy ecosystem; they shape population dynamics, interspecific competition and appear to be important drivers (and part of) biodiversity. The fear of epizootics and diseases has caused the implementation of management strategies which involve the vision of “aseptic” ecosystems. Examples include systematic rabies vaccination in natural areas, and the Bovine Spongiform Encephalopathy crisis, which has brought deleterious consequences for birds of prey and obligate scavengers in Europe.

Some thoughts on current discussions

Peter Bridgewater, E-conference chair, JNCC, UK

Christian Prip's point - It really highlights the issues, I think, which others have previously raised in various ways. Today it seems the biodiversity community has lurched from wagon to wagon in a train careering out of control, trying to find the magic place where everyone else on the planet will automatically believe us.

Real linkages between biodiversity and ecosystem services certainly seems to be an important area for further work. It is part of the package that many contributions have made on the need for a more focussed and integrative approach.

Peter Bos with his homily on communication states the message clearly its communication, communication and communication! But if we ourselves are unclear then we won't have an attentive audience! Peter's question 'if more knowledge of certain species and their habits is really making a difference in dealing with today's major biodiversity challenges' is a key one, which brings us back to the social science- natural science interface. Many mention the links with politics, economics and other social sciences. Yet we do not have easy or profitable conversations between natural scientists and social scientists, so developing common research frameworks is obviously an urgent task. UNESCO has for decades maintained separate social and natural science sectors, with not even a semi-permeable membrane between! How is this gap to be bridged?

How can we treat biodiversity in an integrative way? Martin Sharman takes a more reductionist approach. He proposes in the end though a single very synthetic approach but how to actually implement that? Ferdinando Boero agrees we need to give away the century of reductionism and go for more integrative approaches.

Jeffrey McNeely talks of a consensus, or productive diversity I tend to think it's the latter, and it's the latter we need! Adrian Manning is specific about rethinking the questions and needing a new perspective although many of us seem to be echoing this theme. He is more 'out there' than most however, but expresses the need for research at the landscape level.

Then Pablo Goicoechea brings us to genetic diversity, and magic numbers. There is, it seems to me, a danger here politicians love numbers like this as it will solve everything if we can just have 500 effectively reproducing members of each species then the rest is for biofuel! Sorry that's too flippant Pablo's point is serious, and very important to understanding the genetic element of biodiversity, often ignored in the rush to save an endangered species, which may be genetically unfit anyway. So this would really seem an area for more research, but involving the full hierarchy implicit in Biodiversity.

Some mention a need to conserve and enhance biodiversity but can we do this? And what does enhance mean? Do we really understand the key features of biodiversity?

One of the indicators of success for the target is cited as an increase in protected areas but how much is this affirmation of faith and how much backed by research? Keith Hiscock notes some of this in his 'salty' contribution just how different are the processes in marine and terrestrial environments? And do we need more research on protected areas in the face of change? In understanding protected areas do we need to understand more about the role of ecosystem constructors, keystone species and the like?

Others have touched on the intersection of biodiversity targets with other environmental issues especially renewable energy. This does seem another area where we need better understanding.

I mentioned about the international programme DIVERSITAS Dan Faith picks up the point and notes it will be discussed at the forthcoming open science conference. But do we have examples of successful projects under any of this or any programme that are about integration? Unsuccessful ones? Gaps?

Finally many of you note the role of the Ecosystem Approach but do we need research to show how the EA works or can work?

RE: Some thoughts on current discussions
Biological uncertainty principle

Stephan Helfer, The Royal Botanic Garden Edinburgh, UK

It occurs to me that we may be dealing with something like Heisenberg's Uncertainty Principle, whereby we cannot estimate satisfactorily both the position and the momentum of biological change.

RE: Some thoughts on current discussions

Martin Sharman, European Commission, Brussels

Targets need to be set in context. What are we trying to achieve with this target? Given the multi-crisis our species has brought upon itself, the context must surely be sustainability. If we cannot swiftly abandon our current suicidal attempt to ensure endlessly growing consumption, and convert our energies into energetically devising and implementing a sustainable society, humankind (and not the non-human component of biodiversity) will discover, in short order, that it is not sustainable. At least, not sustainable at the present levels of population and rates of consumption; perhaps we will discover that thinly scattered New Palaeolithic settlements can be sustained. Provided, of course, that we can remember how to make stone choppers, or catch animals that don't want to be caught, neither of which is a given. What target might help us to determine that we have established a sustainable relationship with the non-human elements of biodiversity? I suggest targets like this: the wild populations of every species of non-human primates are growing, and at a rate faster than the human population, and the area of the planet occupied by healthy coral reef is constant or increasing.

I feel that we must realise that the reductionist approach to our world has not only given us every scientific advance since Descartes, but has simultaneously contributed in very large measure to our present predicament. We have led ourselves sadly astray by divorcing ourselves (but only in our minds) from nature, and in divorcing our drive for technology from our understanding of its consequences on the rate of growth of the human population and of its appetites. It is not just that we need interdisciplinary research, which we do, but more; we must understand at a very fundamental level that "society" and "nature" are not separate. They are simply different perspectives on the same reality. A complex reality, yes, but it does not help our understanding of that reality to treat it simplistically. The world, Nature, or biodiversity will not be dominated, and we have been fooling ourselves to imagine ourselves separate. Aldous Huxley told us that "facts do not cease to exist because they're ignored" and we must not use science or technology to ignore our intimate entanglement with nature. Our targets - if we really need targets - must be holistic. They must take into account, as far as human ingenuity can devise, the interplay between humans and the non-human component of life on Earth. But they must also recognise that while we need biodiversity, biodiversity does not need us.

My conclusion is this: that any targets we set must serve to guide our behaviour on a conceptual scale that goes far beyond protecting wildlife. A target must serve to give us direction and hope. It must be of practical benefit to guide everyday behaviour. It must be something that all of us individually and collectively, across Europe at least, feel ownership for. It must be something that helps to move us swiftly away from unsustainable behaviour – perhaps by making such behaviour socially unacceptable. Finding such a target will not be easy, and will require a great deal of research, involving natural and social scientists, economists, historians, artists, philosophers and lawmakers working together in an urgent and important effort. It will not be easy to turn this great fleet of humanity from its present dangerous course, but I am not alone in believing that if we do not do so, and quickly, there is little cause for optimism about the human future.

RE: Some thoughts on current discussions

Peter Bridgewater, E-conference chair, JNCC, UK

I would like to draw your attention again to Martin Sharman's thought provoking remarks:

"Our targets - if we really need targets - must be holistic. They must take into account, as far as human ingenuity can devise, the interplay between humans and the non-human component of life on Earth. But they must also recognise that while we need biodiversity, biodiversity does not need us."

We should remember as we agonise over the forthcoming sixth extinction wave that we are a product of the first five... And that after each previous extinction event it was not the dominant form(s) that survived...

I think we do need targets because we like such things as a species and they (may) help us focus. But the real imperative lies in trying to find holistic and integrative approaches.

Can any contributors help in these final hours (of this debate!) by giving examples of such projects which have actually worked? (or even haven't - failure is the real teacher not success..)

RE: Some thoughts on current discussions

Sandra Bell, Durham University, UK

I would like to respond to Peter Bridgewater's invitation. A few years ago I coordinated an EU funded project on wetlands based on a synthesis of social and natural science research. The project was inspired by the kind of holistic ideas expressed by Martin Sharman. The final report was commended and results disseminated through conferences, journal papers and local workshops. To this extent it might be considered a success, yet the work had very little direct impact.

Our research revealed serious failures in environmental governance and the implementation of conservation regimes, especially regarding relations with local people. Yet none of the parties responsible for these problems was held to account by bodies that fund and authorise their work.

If research is meant never to rock any boats or be deployed to challenge the status quo then the scientific community and the science policy interface will become merely self-serving and the setting of targets treated with suspicion by a cynical public.

RE: Some thoughts on current discussions

John Caesar University of Guyana

Guyana has a Shell Beach turtle protection programme which has seen indigenous people of the community become guardians of the nesting place for five of the world's marine turtles. Education has curtailed the excessive harvesting of turtle eggs for consumption and poaching of adults, in exchange turtles offer other livelihood opportunities such as non-timber forest products - Carapa oil industry by the Guyana Marine Turtle Conservation Society.

The Iwokrama Rain Forest project¹¹ has also seen progress with management of the giant freshwater fish Arapaima.

The Equator Prize projects also provide some good examples¹².

¹¹ Iwokrama International Centre for Rain Forest Conservation and Development <http://www.iwokrama.org/home.htm>

¹² Guyana marine Turtle Conservation Society <http://www.gmtcs.org.gy/>

Numbers are not dangerous

Pablo Goicoechea, NEIKER-Tecnalia, Spain

I certainly agree that if our goal is to halt biodiversity loss (or to gain diversity quality, etc...) we need to be diverse ourselves. But this is one of the most recurrent ideas throughout the conference, so I will not add to it. However, I would like to clarify the magic number issue (just in case any politician stumbles into this arena).

Numbers are not dangerous. Misconceptions and poor communication are.

I can see the dangers in the magic numbers. Peter Bridgewater has put it in an excellent way, so let me try to clarify the idea that I communicated so poorly.

We are far from knowing how much genetic diversity is needed to maintain populations or species (I prefer populations because it highlights the interplay among individuals, part of their ecological interactions). Ferdinando Boero named the cheetahs, a genetically depauperated species, apparently “not so threatened”. Well, let's take the example a little bit further: self-breeding organisms (such as peas) do not contain any diversity, their populations do not contain any genetic diversity, but surely most of them survive perfectly and do not have any risk of extinction. Therefore, one could argue that genetic diversity is not needed for conservation.

The first misconception: genetic diversity is not needed for an individual's survival, but it is needed to preserve the evolutionary potential of populations and/or their potential to adapt to environmental changes. For the example of self-breeding organisms, genetic diversity is found when summing up populations from different origins/environments; which means that when confronted with environmental changes some populations will die while others survive and colonize the new available lands. Unfortunately, we do not have cheetahs living in different ecosystems/environments.

The genetic diversity of the species can be partitioned in various ways. One of the most used is: within individuals, among individuals, within populations and among populations. This clearly shows the misconception in Peter Bridgewater's political proposal: he would be forgetting the among populations component of genetic diversity. But he could answer: then what happens if the among population component is very small compared to the other two? This could be the case, for example, in the comparisons among European temperate oaks that were genotyped with several types of genetic markers.

The second misconception: Molecular markers are a good way to rapidly estimate differences among populations. But markers are usually neutral and they tell us very little about the genes that are important for adaptation/evolution. In fact, when looking at results from oak provenance tests, we find a huge amount of adaptive differences among populations from different parts of Europe. So, why do we need genetic markers? Because failure to find differences were not due to the usefulness of the markers, but to the use of wrong genetic models (Jost, 2008)

So, let's try to put the magic number into the appropriate perspective (My) Poor communication: Conservation and restoration efforts should take into account the evolutionary potential of populations and species. To preserve it, a certain minimum number of reproductive individuals per population are needed. If possible, small populations should be allowed to join (naturally or artificially). However, caution is needed to preserve, “ex-situ”, particular gene pools that could disappear in the mixing process. Ideally, the number of different populations from the same species that are the subject of conservation efforts should be large.

Functional ecology and appropriate tools give simple guidance

John Hutcheson, Biological Systems Ltd., Rotorua, New Zealand

The implications in policy, management, research, education and philosophy are enormous because all actions need to be viewed within the functional context to be meaningful. However, the perspective provides simple, pragmatic and meaningful understanding, and rapid and intuitive solutions to apparent paradoxes. Legislation cannot precede policy and appropriate policy cannot precede understanding. Life regulates our environment and so sustainability can only be evaluated within the context of what natural ecosystems do.

The answer to this 'highest priority' question is that ecosystems increase their capacity to buffer environmental extremes, because the environmental extremes beyond the biosphere kill most multicellular life. Biodiversity provides the functional flexibility necessary to do this, with successions proceeding from bacterial, through to insect, or fungal dominated recycling systems. Thus the generation and management of buffering capacity forms an essential biological principle that shapes ecology, natural selection and evolution. It also (of course) underlies most human endeavour and psychology. As all understanding derives from context, this functional context changes our view of the world. The perspective enables many difficulties to be rapidly re-evaluated and resolved within the meaningful context of functional ecology, rather than the contrived contexts of discipline, funding, reductionist a priori questioning, and in particular, the null hypothesis.

Recognition of this functional picture and of the conceptual model required to understand it, derived from studies of ecosystem dynamics and beetle communities in NZ. These showed drought resulting in an increase of site water retention capacity in relation to site needs as signalled by changing plant nutrition. While the building of capacity to buffer environmental fluctuation is apparent in all areas and at all scales of biology, it has not been recognized as an underlying principle because this is prevented by the methods demanded by the linear model of laboratory science, which itself is unworkable in natural ecosystems.

Natural ecosystems demonstrate an alternative, nonlinear, model that enables rapid integration of disparate, fragmented and multi-scale information. The nonlinear model demands the explicit definition of context first, and then the examination of the qualitative nature of the cross-scale pattern resonance. All nonlinear systems are defined by such pattern resonance, and may be understood via their qualities, even where these may be non-quantifiable in any precise manner. Such pattern resonance naturally integrates a thematic framework for study, understanding, management and policy.

The nonlinear functional perspective substantially alters our understanding of everything we think we know, but it also offers simple and pragmatic guidance to the enormous confusions and lack of ecological knowledge due to the dominance of the linear model. Most importantly the functional perspective rapidly conveys intuitive understanding of the real (i.e. functional) value of biodiversity to society.

Buffering capacity provides a general functional biological theme. This is required by an environment of deadly extremes and these drive recycling activities and succession. In ameliorating extremes, ecosystems acquire energy, so the accumulation of the biosphere is dependent upon environmental fluctuations. Biology is nonlinear exploratory behaviour by conserved elements with malleable connections, and natural selection by unfamiliar extremes has resulted in the evolution of collaborative biological systems to help buffer the environmental extremes.

This functional perspective supports many current common-sense responses to environmental problems (e.g. reforestation). But it also emphasizes that depletion of global buffering capacity will lead to climatic instability, and that the path of mankind is marked by desertification. This means that research, policy and management should be directed toward replenishing the current global depletion of buffering capacity.

The fact that increased atmospheric CO₂ is helping to achieve this shows that current interpretations of carbon emissions as ecologically and socially harmful need re-evaluation within the functional context.

Targeting Interdisciplinarity

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Summary: The most pressing questions in biodiversity transcend disciplinary approaches within natural science. Many research questions require social science, economics and other scientific disciplines, integrated through interdisciplinary approaches. Interdisciplinary research and training is urgently needed to meet this challenge.

The 2010 targets raised hope and awareness, within the environmental community at least. Member States were actively involved. Still, the targets failed due to conflicts between different policies and an overall lack of enforcement.

Many questions remain with the 2010 target. Was it the intention to achieve the target or to motivate the actors involved? Does the failure to reach the target affect the motivation of those actors? Are targets useful per se? Would small scale targets have achieved a different outcome? Would the same outcome have been achieved without this target? Was the public considered as an important actor?

Communication of targets is essential, both in general outreach and providing practical guidelines for the public to act upon. Research should therefore identify processes that encourage the public to achieve future targets. These processes could be used to empower the public both to act and disseminate information about biodiversity loss.

Research is needed to understand the motivations and behaviour of the communities involved in setting the 2010 target. Research is also needed to evaluate the consequences of broad targets compared with detailed targets or not using targets in biodiversity conservation.

Although the second point of interest of this e-conference relates to setting, monitoring and managing targets, what we really want to see is research on how to achieve targets. In particular, the marginal utility of different conservation measures with respect to achieving the target. We also argue that monitoring progress towards targets should be independent from the policy-makers who set targets, and there should be greater enforcement, with legally-binding, explicit measures included in environmental legislation.

Many research priorities have already been identified in this e-conference. However, the greatest priority is to develop interdisciplinary approaches to the challenge of achieving post-2010 policies, bringing natural, social and other disciplines together. Training the next generation of scientists in interdisciplinary research is therefore urgently needed.

Enough science, now for the politics

Pablo G Goicoechea, NEIKER-Tecnalia, Spain

A few lines to support the views from Francois Bonhomme and others:

We (scientists) are not responsible for biodiversity loss. We (humans) are an invasive species at the top of the trophic chain (predators). We destroy most of the biodiversity in the new niches we colonize. At this moment, there are few places in earth where we don't profit.

Now for the politics. Stopping biodiversity loss has many similarities to stopping temperature increase. It is not something a few individuals can be charged with, but we need a global consensus. There is ample agreement among (most) members of the climate change community regarding the indicators and the severity of the problem. And economists have foreseen great losses. Yet, some presidents tried to buy scientists to disagree. And the rest put the frontier in 2050. We don't have such a strong message regarding biodiversity loss. Do we seriously believe we can get something better than them? We should learn from climate change experiences. We need to have a consensus, a clear message (something politicians can understand):

The disaster is here and we can not stop it (please, forget the nice words and the unrealistic objectives). Alleviating the problem is a political issue. We know enough to inform knowledgeably. More money for research means better information, not solutions. We need to get to the media. We need the NGOs in order to increase awareness (the media follows them). Unfortunately a large part of society sees them as tree-huggers. We should support them and convince society that they are not fools but serious people worried about our planet.

I have tried not to be pessimistic; just a little bit bold. These ideas have come in response to several contributions in this e-conference and an opinion article in last week SciDev.net by Mike Hulme (from whom I borrowed the title):

<http://www.scidev.net/en/opinions/climate-change-enough-science-now-for-the-politics-1.html>

RE: Enough science, now for the politics

John Caesar, University of Guyana

Climate change has taught us lessons because in some regions the evidence is there for ordinary folks to see. In Guyana's case science meets policy through Guyana's Jagdeo ecology policy for biodiversity and ecosystem sustainability.

Under the auspices of Guyana's President Bharrat Jagdeo, a bold climate diplomacy initiative¹³ buttressed by recognition of the ecological and economic values of standing forests in the climate change mitigation menu of measures has been articulated. Recognizing tropical rain forests provide a plethora of ecosystem services that support and sustain the well-being of its citizens and more so its indigenous peoples who are more culturally dependent on forest biodiversity and related services. The initiative advocates avoided deforestation for climate change mitigation and adaptation. The national ecology policy framework for mitigating climate change is rooted in a Constitutional environmental ethos enjoining citizens to care for the environment.

¹³ Office of the President. 2009. Guyana Low carbon development strategy

<http://www.lcds.gov.gy/images/stories/Documents/LCDS.pdf>

Office of the President. 2009. Guyana Low carbon development strategy National Consultation report

2009. <http://www.lcds.gov.gy/images/stories/Documents/lcdlaunch.pdf>

http://opnew.op.gov.gy/index.php?option=com_content&view=article&id=585:consultations-on-guianas-draft-lcds-launched&catid=34:bulletins&Itemid=70

Office of the President. 2008. Creating incentives for avoided deforestation

<http://gina.gov.gy/booklet%20on%20avoided%20deforestationf.pdf>

Emerging from this national ecology policy advocacy is a government white paper entitled 'Creating incentives for avoided deforestation' which fully outlines the framework. Guyana's climate change era ecology policy on avoided deforestation seeks to provide a model economic valuation construct for rewarding developing countries endowed with large pristine rain forests with the requisite economic returns on ecological services provided for climate change mitigation. In doing so local initiatives would ensure rain forest ecosystem sustainability and the achievement of the socio-ecological paradigms envisaged in the Millennium Development Goals through avoided deforestation.

Some final thoughts

Peter Bridgewater, E-conference chair, JNCC, UK

Firstly a huge thank you to all who took part in presenting keynotes and posting in the discussions. Certainly the recent postings have highlighted some of the key issues – yes we need to be holistic and integrative, crossing social and natural boundaries, but still if the results of such work remain in the science domain ignored, deliberately or accidentally, by policy makers then we are not making progress.

Thus it seems we need to ensure our social science colleagues are helping by promoting or undertaking research on how science work which is tailored to policy actually makes a connection with the policy makers. But we can't make listen those who do not wish to hear, and thus I come back to communication, communication, communication as part of the formula we need to follow. The best results published with five stars in Nature or Science, yet not communicated to the right people in the right way will not change anything.

We also need to make sure we are communicating our results in a way that policy makers understand, and offer them choices. It is rare that there is only one way to things, or one true way, in science. Yet often that's how things are portrayed. It's also clear that integrative approaches are needed, but many are afraid to embrace the 'shock of the new' by indulging in that work and, it is fair to say that funding for such work is also rare, and sometimes with impossible strings attached.

Using the full hierarchy of biodiversity in research is another theme – yes, biodiversity may have been coined a term for political reasons, but the power of the concept is that it embraces a hierarchical approach. Yet too often biodiversity = species is the equation used. The need for a focus on the genetic elements of biodiversity, in a holistic framework is as important as seeing ecosystems as engines for services, but also homes for species and their populations. And of course we still need reductionist work to help understand specific problems, and we need, on a human level to recognise that many biodiversity scientists are actually not so comfortable outside of that paradigm!

The Millennium Assessment is often used as a modern miracle example of what is needed. Indeed it was good, even though it took some time for some policy areas to agree the results. But for me the good thing from the MA was not the results, impressive and detailed though they were, but the development of the conceptual framework. We need more of that thoughtful work to continue.

Some contributions have also drawn our attention to the need to use different optics – are we really seeing the right landscapes? Do we really understand the role of genetic markers versus gene expression and the real population size needed for conservation? If we don't, we might preserve; yet cut off evolutionary potential. Here is where we also need to think at least 4-dimensionally, including time arrow in our work, and understanding our position as fairly short-lived animals. (I think the oldest living organism is regarded as *Lomatia tasmanica* in southern Tasmania, which appears to be one individual aged between 43,000 to 44,000 years. And guess what? Right now it's threatened by *Phytophthora cinnamomi*, introduced by guess who?)

One final point for this discussion could we come up with an answer to the question 'how much biodiversity do we need'? I ask because if climate change can give a figure, surely we can, my political friend will one day say! And the problem is that if the analogy of the early days of biodiversity that losing it (meaning species in fact) was like rivets dropping out of a plane – by now in most countries the plane would be grounded. Our arguments for why we need biodiversity are frankly naïve, and there lies a big problem for us.

Still with the inventiveness and open-mindedness shown by participants in this e-conference, I am more heartened than ever that these challenges can be overcome, and we can help human survival on planet earth – as long as we don't add too many more of us.



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Appendix 1

The wicked problem of biodiversity: Targets or sustainability? – that is the question **Martin Sharman,¹⁴ Brussels**

Wicked problems: The climate is changing because humans are rapidly converting fossil carbon into atmospheric greenhouse gases. Why is biodiversity changing?

Reducing the concentration of greenhouse gases in the atmosphere would (perhaps) slow future change. This is true no matter how complex the mechanism by which buried carbon becomes atmospheric gas, or by which those gases drive climate change. The target almost sets itself – or it would if politics and economics did not complicate things. What target pops out at you from the radical anthropogenic transformation of biodiversity?

Stopping anthropogenic climate change will certainly be difficult. But we know what distinguishes the observed rate of change from the desired rate of change, and we know what actions would narrow the gap between what we see and what we'd like to see. In this respect, then, climate change is not a wicked problem – though in other respects it certainly is. A wicked problem¹⁵ is one that is poorly understood and resists clear definition. A text-book example of a wicked problem is this: what must we do to stop the further loss of biodiversity? If we can answer that question, then we can begin to set sensible targets.

What is the cause of the loss of biodiversity? We can not point to a single driver like “humans are transforming fossil carbon into greenhouse gas”. Instead it has many linked causes. They include profit-driven, growth-based economies, a growing human population with steeply increasing demands on the living world, ineffective institutions, poverty, accounting that externalises environmental costs, greed, war, protectionism, climate change, lack of political will, subsidies, corruption, inequitable access to the benefits of living resources, wilful ignorance, and a global trade regime fit for a different planet. All of these causes also help to change the composition of the atmosphere, but in every case, we can point to one cause: emission of greenhouse gases. In that tangle of causes, can you or anyone else say where, exactly, lies the cause of loss of the living fabric of our planet?

Well, OK, let's try something easier. Can you define a desirable status for biodiversity? One that I could step outside and measure, as I might measure, with appropriate instruments, the concentration of greenhouse gases in the atmosphere? Perhaps the word “status” is unfair, since ecosystems are dynamic. But while it may be more accurate, it does not make the question any easier to answer – if you can't define a desirable status, how might you go about defining a desirable dynamic for biodiversity?

These are quite clearly not idle questions. Nor is this: in what respect do the current status and trends and dynamics of biodiversity differ from what you'd like to see? That's easy to answer in general, vague, non-operational, hand-waving and superficial terms, but how would you set out your stall to heads of State and Government? Could you tell them what we must do to turn what you see into what you'd like to see? Can you write down an operational recipe for stopping biodiversity loss, equivalent to the 3-word “greatly reduce emissions” recipe for stopping the climate from changing?

Can you define a boundary for what you mean by biodiversity – or its loss? Is your own working definition of biodiversity (do you have one that really works?) shared by most other people – or even by anyone else on the planet? Nobody can answer these questions in any useful way for one reason: biodiversity loss is a wicked problem. Take any problem, ask

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The views expressed are purely those of the writer and may not in any circumstances be regarded as stating an official position of the European Commission.

¹⁵ http://www.uctc.net/mwebber/Rittel+Webber+Dilemmas+General_Theory_of_Planning.pdf and you'll find many other interesting sources of information by entering "wicked problem" in Google.

the equivalent questions, and if you get no useful answers to any of them, it's a wicked problem.

Wicked characteristics, stopping rules and targets: The problem of “biodiversity loss,” like every other wicked problem, cannot be formulated once and for all. Our incapacity to do so is not a failure of imagination or competence – it is part of the nature of the problem. We can't even agree on what we mean by “biodiversity,” because biodiversity is a boundary object¹⁶. The details of the problem of its loss, the constraints on possible solutions and the resources needed to solve the problem change in time and space and with scale. Problems overlap and change shape depending on your point of view. Most are horribly fractal. Solutions are typically local and depend on how the problem is perceived and framed – and every one of us has different frames for understanding the problem, because our world views differ. Some frames are mutually contradictory, and conflicts abound because one person's solution is another person's problem.

The nature of biodiversity loss also means that the problem will never be definitively solved – we cannot achieve the sustainability of a set of complex, dynamic and interdependent systems by switching off the autopilot and going to sleep. The problem is wicked because as the system changes (in ways that are often difficult to recognize), the contradictory requirements we have of the system are constant only in that they are permanently changing. The information we have about the system is incomplete and contradictory, and however well-meaning it may be, work done to solve one aspect of this wicked problem often generates other wicked problems.

One of the characteristics of a wicked problem is that it has no stopping rule. If you're fixing a puncture, you stop when the puncture is fixed. How do you know it's fixed? Because when you pump air into the tyre, it stays in. The solution, and the rule that tells you when the problem is solved, is inherent in the problem. Thus we will be able to tell if we manage to reduce the concentration of a given greenhouse gas to a given number of parts per billion, even if the larger problem of anthropogenic climate change itself has no obvious stopping rule. It is not going to be easy to tell when (or rather, if) the climate has stopped changing as a direct consequence of human activity. But one infinity can be larger than another (for example, many, many more numbers are multiples of 2 than are multiples of $(2^{43112609})-1$, but both sets are infinite¹⁷). It is going to be considerably more difficult to tell if biodiversity loss has slowed or stopped than if the climate has stopped changing. (If I were cynical, I might say that this aspect of the wicked biodiversity problem is irrelevant, because we are in fact doing nothing of much significance to stop biodiversity loss, and it isn't going to stop on its own.)

You don't need me to point out that “stopping rule” and “target” can be made congruent. The fact that wicked problems have no stopping rule is the reason for the assertion that no target will ever tell us whether we have stopped biodiversity loss. Furthermore, since we depend on the wellbeing of life on Earth, we cannot simply put the problem down and step away from it. If our species continues to drive down biodiversity, our species is not sustainable. There is no point at which we can sit back and say, “that's good enough,” or “we've done our best.” We cannot stop trying to halt biodiversity loss because we get too frustrated, or too cynical. If we do, the consequence is unavoidable: if nothing else stops us first, then the continued loss of biodiversity will eventually stop us.

Tractable bits, targets and sustainability: A target is, in some sense, a solution. “If we reach this target,” we imply, “we will have solved this bit of the problem.” If we accept that biodiversity loss is a wicked problem, then there are two ways to approach target setting. Either we break tractable bits of the problem off from the main

¹⁶ http://www.edinburgh.ceh.ac.uk/biota/Archive_scaling/6710.htm

¹⁷ At the time of writing, $(2^{43112609})-1$ is the largest known prime number, so I thought I would honor it. But I could have chosen any number bigger than 2, and the point would be valid.

problem, and set targets that will tell us if we've solved those bits. This, in effect, is what the CBD tried to do when it established indicators of this and that¹⁸.

Or... but there is no or. You can't actually set targets for a wicked problem. You can only break off bits and set targets for them. Breaking tractable bits off a wicked problem has an interesting result. The black heart of the problem remains just as big, and just as wicked. Knowing that farm birds have recovered to a given level, by some measure or other, tells us nothing at all about most of the other important dimensions of biodiversity.

Why is this? Why can't we find indicators and targets that tell us not just about themselves, but something about other bits of biodiversity? The main reason is the complexity of living organisms, their environment, and the multiplicity of the connections and relationships between them. Unlike our mathematical assurance when dealing with much of the (fiendishly complicated) chemistry and physics of the atmosphere, we can describe with confidence no more than a handful of the greatly more complicated and very much more obscure interactions in any habitat. We simply do not know how it all works. We don't even know the basics, such as whether ecosystems become more resilient or more fragile as they gain or lose complexity, or how the diversity of life in an ecosystem relates to the services it provides.

So is there any purpose in setting targets for biodiversity? To me the answer is far from clear. My gut feeling is that there are good reasons to set targets for certain dimensions of biodiversity, including targets related to the conservation status and trends of species, measures of connectivity and fragmentation of ecosystems and trends in their extent, the ecological footprint of individuals, companies and countries, the marine trophic index, and public awareness of the state of the planet. But I also suspect that we need to approach the problem in a less mechanistic, reductionist way if we really intend to solve it.

To my mind at least, setting targets for various dimensions of biodiversity suggests that these things can be achieved on their own, independent from and without reference to a wider context. The CBD website says, "Clear, long-term outcome-oriented targets... can help shape expectations and create the conditions in which all actors... have the confidence to develop solutions to common problems." It doesn't say they encourage you to review and if necessary change your world view, values, beliefs, behaviours and the way you do business, which I think is what's needed.

If we're going to put a lot of effort into establishing a target, we must first ask ourselves some important questions. Before we begin work on defining the target itself, we surely need to know what real-world outcome we want to achieve by setting the target. Defining a desired outcome should help us to imagine useful targets¹⁹. Since any outcome that uses the word "biodiversity" is an abstraction, let us suppose that the outcome we want is "a sustainable and mutually beneficial relationship between humans and the living world" by a date not too far in the future. Let us not worry just yet about the meaning underlying this statement of outcome; it may become clearer as we ask, and try to answer, some of the other questions.

Something about sustainability: Well, actually, let's worry a bit about the meaning of that outcome. What is that "mutually beneficial" qualifier doing there? To be honest, there are several potentially sustainable relationships. The state of being dead is about as sustainable a state as you, or I, or a planet can reach. The state of being impoverished, ill and miserable is also apparently fairly sustainable, given the evidence we sometimes zap past on TV – or if not sustainable, seems to be the

¹⁸ Convention on Biological Diversity indicators: <http://www.cbd.int/2010-target/framework/indicators.shtml>

¹⁹ Understanding the desired outcome may also help to avoid the gruesome spectacle offered when worthy targets are met by the simple expedient of redefining things. As an example, to help private utility companies to achieve the (state-set!) target of 15% of their electricity from renewable sources by 2025, the Indiana legislature considered (in April this year) re-defining renewable energy sources to include clean coal and uranium.

permanent lot of a sizeable fraction of our species. Sustainable by being dead? There's little likelihood of us killing Gaia²⁰, but she will sooner or later end her interesting experiment with humans. But wouldn't it be better for us, at least, if that "later" is in a million years or so, when we evolve into something else? What about "impoverished" as sustainable?

Earlier I asked whether you could pick a single cause for biodiversity loss. I have a partial non-operational answer that involves thermodynamics, homeostasis and sex. Photosynthesis decreases entropy. Human well-being is achieved in large part by increasing the entropy of other elements of the living world. Our global population has bloomed because we've found out all kinds of clever ways to reduce death rates but never worked out acceptable ways to keep fertility rates in step. We've reached the point where photosynthesis can no longer decrease the entropy of the planet's surface fast enough to balance the anthropogenic rate of increase in entropy. So biodiversity is lost to permit short-term human well-being.

If short-term human well-being is the problem, then to remove the problem, there are three elements that might change: short-term, human, or well-being. Of the three, I think we'd all prefer that it was the "short-term" that changed to "long-term." The issue needs no more than a moment's thought to see that "long-term" requires a mutually beneficial relationship. I think we need not stress the "mutually beneficial" bit any more, so from now on, I'll just assume that by sustainable we mean an agreeable world for people, where neither humankind's demands, nor the anthropogenic response of the planet, endanger each other.

So, let's look at "a sustainable relationship between humans and the living world". Perhaps the first question should be, what is the geographic scale of the outcome? Can we achieve the associated target piecemeal, bit by bit, across the planet, or do we have to think about the planet as a whole? Can we imagine a world where human demands on most of the planet's biosphere could be sustained indefinitely, while in a few plague spots, biodiversity loss continued?

The ethics may be dubious, but the answer may conceivably be "yes"; at least, nations have forcefully asserted their right to deal with the biodiversity within their borders as they wish. But is it really "yes"? If a plague spot can be functionally isolated from the rest of the system, then fine. But if the function of the whole requires that some bit of the planet must lose biodiversity, then I don't see how it works. Biodiversity declines in that plague spot until it flat-lines. No more can be lost there, but the function of the whole demands a rotten bit, and the plague must spread. Gradually, bit by necrotic bit, the planet dies. If this seems fanciful, think of the parlous state of the oceans.

But given the nature of biodiversity – especially its local geographical character and coherence – it is possible, and perhaps even in some respects sensible, to think of outcomes at national or even more local scales. Perhaps we can achieve "a sustainable relationship between humans and the living world" one place at a time, but in practice it will certainly be more complex, since almost all our modern relationships between humans and the living world involve dependencies that extend well beyond any local boundaries. Even if we accept that we can set targets for smaller geographical regions than the whole planet, we must nevertheless ensure that those dependencies are accounted for in the formulation of the target.

Is it realistic to expect that we can achieve at least locally "a sustainable relationship between humans and the living world"? I think for most parts of Europe, at least, the answer to this is "possibly," though it would take a great deal of careful research to be sure. Currently about half of Europe's consumption is maintained by importing resources from

²⁰ The Gaia theory proposes that organisms co-evolve with their material environment at the planetary surface in a tightly coupled process from which emerges self-regulation, within limits that allow for life, of temperature, oxidation, acidity, and other characteristics. Homeostasis is an emergent property of the system, but its set points are not guaranteed. The co-evolving system can transit into a new quasi-stable state, in which the values of these characteristics are collectively readjusted to a new set point, either when provoked by external events or when organisms evolve that substantially alter one or more characteristics of the system.

other regions²¹, and using the atmosphere to dump greenhouse gases, but a combination of legislation and education might be able to bring consumption and waste back within limits. This would be difficult and opposition would be powerful, not least because European economies depend on growth, and it is not clear how they would survive a reduction in consumption followed by zero growth.

The market economy is not the only economy, but it is the one that grows by allocating resources optimally as a function of their relative scarcity, and that goes on growing and allocating resources irrespective of the size of the economy. The market economy is dangerous because it neglects a small detail: it operates on Earth. Growth can be sustained only while the sources and sinks of the planet have room for it. Growth depends on surplus. Surplus land, surplus water, surplus energy, surplus natural resources. But there is no more surplus²². Zero growth seems to be an absolute requirement of sustainability.

My hoped-for outcome is wishful thinking, and nothing more, if we can do little or nothing to achieve it. Is it reasonable to think that we can in fact move toward the outcome? We would have to find ways to use renewable resources only at rates that nature can sustain, and to reduce the need for non-renewable energy to zero, or as close to zero as possible.

It is not only about energy, for if oil is the most spectacular example of heedless consumption, it is not the only non-renewable resource we rely upon. Increasingly effective ways of extracting non-renewable resources maintain or even increase their availability, and in some cases drive down their price²³. Assuming business as usual, this trend will continue up to the moment at which a key irreplaceable resource runs out, or becomes so difficult to extract that it is in effect exhausted. Up to that point, most other non-renewable resources may continue to increase in apparent availability and get cheaper. The economy will collapse in a time of plenty, for want of one irreplaceable non-renewable resource.

Global production of gold, silver, lead, tungsten and zinc will soon fail to satisfy demand, but there seems to be no unambiguous way to predict whether the key limiting resource might be one of those metals, or tantalum, antimony, indium, beryllium, scandium, gallium, germanium, platinum, or perhaps some other obscure and alien-sounding element. For example, nuclear reactors need control rods, and control rods need indium, dysprosium, europium, and holmium. Some also need samarium. Hafnium and gadolinium are needed to make computer chips, while gallium and indium are used to make liquid-crystal computer monitors and terbium is used in optical computer memories and hard drives. Much of modern technology depends on rare elements. Despite what one infamous (and now dead) economist thought, there isn't an infinite supply of copper, and you can't make elements²⁴.

When these non-renewables are gone, they're gone – and with them, mobile phones, computers, monitors, nuclear reactors, superconductors, wind turbines, gasoline, plasma televisions, hybrid car batteries and a host of other things we think are pretty neat – though probably not all at once. It's hard to imagine what happens to today's world if there are no more computers, but without almost any of these things our civilization may get wobbly²⁵.

But let's close the parentheses and get back to the other nightmare. In thinking about what we might do to achieve “a sustainable relationship between humans and the living

²¹ The EU, with 7.7% of the world's population and 3% of its land area, is responsible for between 15 and 20% of the global ecological footprint, and depends on the ecological production of third countries. This can only be sustained up to the point at which those other countries slide into ecological deficit and their populations become sufficiently impoverished, ill and miserable to make it uneconomical to continue to extract ecological resources.

²² Heinberg R. (2007) *Peak Everything: Waking Up to the Century of Declines* New Society Publishers ISBN 978-0865715981

²³ Simon J.L. (1995) *The State of Humanity: Steadily Improving* Cato Policy Report http://www.cato.org/pubs/policy_report/pr-so-js.html

²⁴ Daly H. (2003) *Ultimate Confusion - The Economics of Julian Simon* The Social Contract Press 13 (3) http://www.thesocialcontract.com/artman2/publish/tsc1303/article_1144.shtml

²⁵ Since Chinese companies now own more than 90% of the global resources of rare earths, it's fair to assume that in the short term, most of these things will soon or are already in some sense "made in China".

world” I begin to get a sinking feeling. My hoped-for outcome reveals itself as a wicked problem. Part of the reason for this is that it shares many unfortunate characteristics with the wicked problem of biodiversity loss. Uncertain policy environments with many individual and organisational stakeholders are ideal breeding grounds for wicked problems, especially when the values, interests and goals of the stakeholders are complex, uncertain, unclear, ambiguous, heterogeneous and conflicting – and all the more so when the problem itself is composed of a complex set of elements that interact in non-linear ways. There is little or no linear causality in a wicked problem.

You can’t solve a wicked problem except by solving it: One inconvenient characteristic of a wicked problem is that it cannot be solved unless you try to solve it. This statement is true of most problems, of course, but tame problems can be solved without going through the motions of implementing the solution. They can be solved on paper, or in your head. Unfortunately you can’t solve wicked problems in a model environment, because each wicked problem is unique, and in all its important details, it is unlike any other – and any model is necessarily not itself the wicked problem, and is therefore unlike it. In fact, any problem you can model is by that very fact a tame problem. So to propose a solution for a wicked problem, we have to roll up our sleeves, get our hands dirty, and actually try to solve the problem. That costs a lot of time, effort, and money.

Even more unfortunately, we know beforehand that most solutions will engender unexpected and unwanted consequences, many of them wicked problems in their own right. And nowhere in the small print does the universe guarantee that any problem, far less a wicked one, has a solution at all. Furthermore, because wicked problems have no stopping rule, you never know if you’ve finally solved it. So my answer to the question on whether it is reasonable to think that we can do much towards achieving the outcome is “we won’t know until we try.”

The good news is that we think we know how to achieve it, at least in broad terms. It’s the ecosystem approach, which is based (whisper it!) on hippie teaching: there’s no such thing as a free lunch, there is no “away,” everything is connected to everything else, you cannot step into the same river twice, and you can never do just one thing. I’ll come back to the ecosystem approach later.

If I were the ruler of this land, I would reintroduce some mediaeval ideas. For example, I’d punish company directors found guilty of planned obsolescence by making them spend a day in the stocks while customers throw obsolete items at them. Ducking stools would await those whose advertising encourages the perception of obsolescence (there goes the fashion industry) or over-eating, or the view that performance is a virtue when it comes to motor vehicles. To be less frivolous, legislation and advertising alike should not encourage economic growth, but a frugal, responsible society that aims to reduce, reuse, repair and recycle. Not going to happen? No. Maybe not.

Why? There is a one-word answer: debt. Our economies are designed to generate profit for investors. If you invest money, you expect to benefit from it – you want your money back later, with interest. Your investment is a bet that your future worth will be bigger than it is today. Your money invested is a claim on future money. Look at this the other way round: to do business, companies, pension funds, building societies and governments borrow money and accrue debt. Debt is to the market economy what nutrition is to you and me; necessary. Interest is paid on loans, which means that our debt-dependent economies are based on the requirement that tomorrow’s economy be bigger in real terms than it is today. The whole of society repays the debt, not just the institution that took it on, because costs (in higher real prices and hence more human labour) are passed on to the citizen. Thus irrespective of tomorrow’s needs, just to pay today’s debt, our successors must cover more land with houses, buy more cars, pay more taxes and – most importantly – consume more resources than we do²⁶.

²⁶ <http://www.chrismartenson.com/crashcourse>

This debt will be paid. Well, not necessarily. There are three or perhaps four ways to get around this repayment. The first is if business, banks and governments default on their loans (say goodbye to jobs and investments). The second is if banks and governments print money (say goodbye to buying power and savings). The third is if an indentured future pays for our debt by going even further into debt itself, mortgaging an ever-ballooning future. But there is still only one pale blue dot²⁷, so sooner or later, the buck stops and our wicked problem gains another sizeable wrinkle. If our children are to pay our debt, to do so they will need more resources than we already use today. How, I ask myself, is that going to be possible? The fourth way of getting around the payment is a bit radical, involving as it does the collapse of the whole house of cards.

I am no expert, and I see no way out of this. But it explains something important. The loss of biodiversity is not just a wicked problem but, to borrow the phrase from the Lund Declaration, it is also a Grand Challenge – though the Lund Declaration lamentably failed to point that out. Perhaps the people who drafted the declaration, which blandly claims that science can help us to achieve sustainable growth²⁸, decided that it is a matter of little importance that the living world is collapsing beneath our weight. Sustainable growth is, of course, perpetual motion by another name, and it is hard to maintain your belief in miraculous motion unless you can simultaneously ignore the fact that the machine is shaking itself to bits.

But if your options are otherwise limited to an entire economy defaulting on loans, universal hyperinflation, or economic collapse, sustainable growth looks like nirvana. And is, I can't help adding, every bit as easy to obtain.

Our leaders seem not to know how to think ahead in a context of swiftly-increasing complexity. Their jobs are not enviable; the challenges are developing far faster than the political process can follow. As a result, if they are planning at all, it is apparently for a war that took place rather a long time ago. Rapid exponential change makes such out-of-date planning inevitable and much of what underpins our societies seems to be changing exponentially. It's very hard to believe it can all go on like this for much longer. It seems that we are living on a cusp. What will befall us in the next twenty years is going to be unlike anything that has happened up to now. This wicked problem is, by definition, unlike any other. The only way to deal with it is to start dealing with it.

Sustainability is forever: an attractive future: If we are going to try to achieve “a sustainable relationship between humans and the living world,” we need to know the current status of that relationship, or at least have a way to establish a baseline, and we need to discover criteria that can be used to assess whether we are moving towards sustainability. This brings us to question the definition of “sustainable” and the meaning of “relationship.”

Our present use of the planet is not sustainable. Achieving “a sustainable relationship between humans and the living world” will require much more than stopping the loss. Whatever sustainable means, maintaining the current number of humans is not an option, and we cannot continue to extract services from the natural world at the rate we do today²⁹. Stopping soil erosion is not enough; nor is stopping the fragmentation of habitats or the damming of rivers. Sustainability is not just a matter of making sure that the rate of use does not exceed the rate of replenishment. We have to take action to reverse many trends if we are to achieve a sustainable relationship with the living world. How, then, to establish a baseline, if all we really know is that today's relationships are not sustainable?

Incidentally, how do we reverse genetic erosion? By reversing the fragmentation and reproductive isolation of populations? No – that might help to reduce future erosion. But what we've lost, what we're losing every day, even every moment – how do you replace what

²⁷ Sagan C. (1994) *Pale Blue Dot: A Vision of the Human Future in Space* New York: Random House <http://www.youtube.com/watch?v=MnFMrNdj1yY>

²⁸ The conference was hosted by the Swedish Governmental Agency for Innovation Systems, which has the official task of supporting research to promote sustainable growth.

²⁹ Vogt W. (1948, reprinted 2007) *Road to Survival* Kessinger Publishing ISBN 978-0548385166

is gone forever? How, I wonder, does one go about setting a target that is anything other than tangential, symbolic?

There are no good, by which I mean operational, definitions of sustainability. For an excellent reason; to attempt to define it operationally is to see clearly that it is a wicked problem. Sustainability is simply too complex an issue to allow for a snappy definition. To know what it is to be sustainable, we will have to do it. And the only way to do it is to hope we know where we're going, set off in that direction, and by dint of blood, sweat and tears, discover, but only several generations later, that we seem to be walking along the right road. Right road, perhaps, but we will never be able to relax because the biosphere is, like all living things, in flux, and has no fixed conformation. We will never know if we have achieved a sustainable relationship with the living world, because "sustainable" presumably means "for as long as there are humans," and for the rest of human history, we will never know what surprises tomorrow might bring.

We will nevertheless have a chance of being on the right road if each year the human death rate is no lower than the birth rate, if soils form no more slowly than the rate at which they erode, if species go extinct no more quickly than new ones evolve, if coral reefs form no more slowly than they die, and if waste, including greenhouse gases, is produced no faster than the local environment can assimilate. There are of course many other such indicators. There are therefore many measures against which we might set and assess the target. Since sustainability is forever (at least "forever" from a human perspective), many of the measures will require patience and long-term investments.

Which brings us to the nature of the relationship between humans and the living world. What is important here, I think, is not whether we should interpret our role as that of master, steward or gardener (or what leads us to think that we can successfully master, steward or garden the Earth before we understand it) but that we at least think about what we want from the living world. And not just what we want for ourselves, but for our children and their children – indeed I would suggest that we adopt the Great Law of the Iroquois and consider the benefit of the seventh future generation. And what better way to think about what we want from the living world than to set up mental pictures of the living world of the future, in which we would want to live? What picture of the future shows a global community in which we would like to live, and that can endure?

"What does a sustainable carbon-neutral society look like?" asks David Orr³⁰. "It has ...local businesses ... local farms and better food ... local employment ...better poetry ...better schools ... fewer shopping malls ... less television and no more wars for oil or anything else." If we were to agree on one or more attractive future worlds, it would then be possible to think about what our relationship would have to be with the living world in order to reach one or other of them.

Responsibility for sustainability: Who is the "we" that might try to achieve "a sustainable relationship between humans and the living world"? Who should agree that the "sustainable relationship" is a desired outcome, and who should be involved in setting the associated targets? Who are the people who will feel ownership of the outcome and the targets, and be given the responsibility for delivering sustainable relationships? Who will account for performance and to whom?

This, of course, is the key issue. It's key for any target, because unless someone feels responsible, you are unlikely to reach it. Brownian motion, or perhaps more appositely, drunkard's walks, are not the best way to reach targets. But for this issue – stopping biodiversity loss – ownership and accountability is the beating heart of the matter. The outcome "a sustainable relationship between humans and the living world" pivots on the word "humans". It implies individuals, companies and governments, but also *Homo sapiens* and the glorious human enterprise. Thus the stakeholder for this outcome is everyone on Earth,

³⁰ Orr D.W. (2007) *Optimism and Hope in a Hotter Time* Conservation Biology Volume 21, No. 6
<http://www.davidworr.com/more.php?articleid=23>

and probably every human institution, too. But most of the world's resources are consumed by a tiny fraction of the world's population. That tiny fraction could do most to establish sustainability, but has the least motivation to do so. Just as countries can for selfish reasons cheat on agreements to reduce greenhouse gas emissions, so individuals, companies, institutions and governments can behave selfishly when it comes to establishing sustainability.

But what do we expect? Most people have never heard of biodiversity or ecosystem services and don't know what either term means. Whatever they mean, most people probably don't think about them at all, far less about their loss. Of the small minority that has heard about biodiversity, almost all probably either equate it with species extinctions, thinking perhaps of pandas and passenger pigeons, or regard biodiversity loss as something affecting tropical forests or, possibly, coral reefs. Something beautiful, yes, but conceptually vague, geographically far away, and disconnected from everyday concerns. What percentage of people could identify any reason to be concerned about, far less any personal responsibility for biodiversity loss? I would guess that it is effectively zero. The same thing is doubtless true of the concept of sustainability – perhaps more people may have heard of it than of biodiversity, but nobody knows what it means.

“Biodiversity” was never a good word, because its meaning is obscure, but it is now also a failed policy; we did not reach the 2010 target. And what are the consequences of that failure? For many of us in the richer, service-economy nations of the world, the quality of life and freedom of personal choice is greater now than it has ever been. We have benefited greatly by the continued loss of biodiversity elsewhere on the planet. That steady draining-away of ecosystems has supplied our rapidly increasing needs for timber, food, cosmetics, medicine, and many other services.

The loss of biological capacity of the planet to support life is rapidly falling off political agendas everywhere. Nobody wants to chase a failed policy whose only observable consequence is the enrichment of the economy and the embarrassment of policy makers. The lesson here is, perhaps, that when setting targets we ought to think carefully about the political repercussions of not reaching them.

Governments are unlikely to do anything serious about biodiversity loss unless they are pushed into it by their citizens and advisors. Companies won't do anything unless it's profitable. And people won't do anything if they aren't even aware there's something to do.

And we're not telling them. Our wicked problem is compounded by good manners and Orwellian use of language. Good manners forbid us to speak of loss, of sacrifice, or of tasteless things like the distribution of wealth and political power within and between generations – and above all, let us never mention the entirely discredited idea of limits to growth. That's just so '70s. By correct use of language we see that there are never any problems, only challenges, which are really just opportunities waiting for us to seize and use to make money. An insoluble opportunity is an oxymoron, so any right-thinking person will clearly see that there is no such thing as an insoluble problem. Global change might look like a challenge, perhaps, but since the only problems we need to focus on are those that we can solve by making a profit, climate change and biodiversity change (never loss!) are opportunities to make money through technological break-throughs and green gadgets. The word “sustainable” must always be emasculated by coupling it with a succubus – “development” does nicely to render it harmless and divert attention from the issue. Oh, and you may once have been a citizen, but my dear, that is terribly old fashioned. Now you are a consumer, a customer, and your duty is to buy and spend and throw things away – only more, please, and faster.

On the one hand, then, ignorance and vested interests lead to a vacuum of ownership of the outcome or associated targets. On the other hand, there's another tricky bit about “a sustainable relationship between humans and the living world.” That is the size of the human population and the demands it places on the planet.

Most current demographic predictions suppose that the human population will not rise much above 9 billion, which is some 2.5 billion, or close to 30%, more than today's population. Humans currently sequester between $\frac{1}{4}$ and $\frac{1}{2}$ of all net terrestrial primary

productivity and ½ of accessible fresh water. Human activities already fix as much nitrogen in terrestrial ecosystems as all other sources combined. It is hard to see how these proportions could be increased to keep step with the projected increase in human populations.

The question about the ownership of the outcome looks like a pair of wicked problems: how can each person take responsibility for the well-being of the whole world? Who is responsible for reducing the human population and its impact on the world? Unless we can answer them, is there any point at all in rabbiting on about sustainability?

Overhaul: What will we have to change if we are going to achieve “a sustainable relationship between humans and the living world”? In our current paradigm, a small minority of humans benefit at the expense of the great majority, and of the environment. This leads to the bewildering, amazing spectacle of a species that is trying to strip everything worthwhile out of its planet as quickly as it can. Humans are busily converting prodigious volumes of carbon into greenhouse gases in a sustained, sweeping and hugely successful effort to reverse the natural creation of diverse and complex ecosystems that build soil, clean the air and water, and provide many other services. The main deliverable of all this energy and toil is obscene wealth for some. Oh, and a raft of wicked problems. Most of us on the planet (but not, in general, the wealthy few) have to deal with one or other problem every hour of the day. The rest of us – living mostly in service economies – can ignore or deny them, or choose to remain in blissful ignorance about them.

Clearly, today’s paradigm does not work. When we’re done liquidating our planet, do we imagine we will slide the key under the mat and rush off to do something else? What will we have to change? Clearly, a new paradigm is needed, one that views our relationship with the entire Earth as a living system with a long-term future. Stopping biodiversity loss, or attaining a sustainable relationship between humans and the living world (which is the same thing), requires a root-and-branch overhaul of the way we do things. The ecosystem approach, or Gaia theory or something very much like it, will have to become the central tenet of the way we do things. In a sustainable world, personal autonomy is less valued than personal growth and community, while cooperation and conscious consumption replace the unethical and unacceptable mind-frames of competition and conspicuous consumption. The throw-away society must end; a sustainable society does not waste things. In this, the sustainable society could model itself on nature, where nutrient cycles and food webs result in very little waste. Resources are used efficiently, over and over again, and one organism’s waste is another’s raw material.

The global economy will have to reduce its demand for resources to the point where “renewable” means what it says and oil and coal reserves are not used as energy sources. This is a significant reduction, probably unachievable without a quick and permanent reduction in the human population and, simultaneously, a decrease in *per capita* demands on the living world. Economies will have to turn away from extraction and instead develop technology to minimize our ecological footprint and to sustain and improve the natural environment. Forestry and agriculture will have to adopt methods and technologies that do not depend on massive chemical input and transport over huge distances, while fishing will have to... what? I’m not sure. Can fisheries work out ways to remain within the regenerative capacity of the fish? If not, we may need a permanent moratorium on industrial fishing. Most significantly, and perhaps most difficult of all, our entire economic system and its underpinning monetary model will have to drop its dependency on growth and debt, and reorient on sustainability.

The bottom line is this: first, if there is a viable way forward at all, its watch-word is sustainability; second, before we can reach a sustainable society, huge obstacles lie in our way; and third, these obstacles are insurmountable if we do not try to deal with them. We will only reach whatever target we set if we put in a huge effort to change the way we do things, direct more resources towards understanding, and make significant investments in appropriate technology. At the same time we will have to thoroughly overhaul our

organisations, and considerably improve the processes we use to grow and prepare food, clothes, and other material goods, and to transport them and us around the place.

No, for biodiversity loss, it's not just a matter of reducing the emission of greenhouse gases. This one is a wicked problem, and it will need, first, some serious thought about what it is to be a human on this planet, and then a serious attempt to live up to the name with which we flatter ourselves: *Homo sapiens*.

Some final questions: There is no realistic plan of actions towards “a sustainable relationship between humans and the living world.” There isn't, but there could be, if politicians, businesses, scientists, industrialists, sages and a lot of other people set to work to create one. It would go like this: use it up, wear it out, make it do, or do without. It would make it a criminal offence to use the word “consumer” and would re-instate the word “citizen.” It would explain that sustainability is a life-long lesson in deportment. A successful step is a small triumph because the book is still balanced on your head. Happy complacency is the last emotion you feel before the book slides off.

But if there were such an action plan, would anyone take any notice? What would motivate them, and why? The plan must clearly show how every individual benefits, and hold up a vision of an agreeable future that we can attain if we act in certain ways.

What resources will be made available to help us into our new paradigm? Well, let's not get too ambitious. Just to stop biodiversity loss, then. If the past is any guide, not a lot. “We will spare no effort to free our men, women and children from the abject and dehumanizing conditions of extreme poverty, to which more than a billion of them are currently subjected.” That's not about something obscure and remote like biodiversity – that's about in-your-face human suffering. The body that made that declaration in September 2000 was the United Nations. Almost a decade later, UN figures show that more than a billion – the same number – still suffer from extreme poverty, 1 in 8 people on the planet are malnourished, and around 1 in 12 experience severe and chronic water shortages. Sparing no effort, all right!

Another question we should always ask about targets is, “how much time do we have to reach it?” In this case, the question is a tricky one, because as we've seen, there's no target to reach, only a long road to walk along. “How soon do we have to start?” has an obvious answer, but unfortunately it involves a technology that we haven't yet mastered – time travel. “How soon do we have to be on the road?” has pretty much the same answer, if you believe Donella and Dennis Meadows and Jørgen Randers, who told us 16 years ago that we were already beyond the limits³¹. But however you look at it, we cannot buy time. Every day we continue with business as usual, the wicked problem becomes exponentially more knotted and complex, increasingly likely to prove intractable.

Can we reach our desired outcome of “a sustainable relationship between humans and the living world” within a reasonable budget? As these musings have shown, I don't think that there are any shortcuts, but there are options. We can either achieve an environmentally, economically, and socially sustainable relationship with the living world, or we can let a broken environment force a future upon us. Because “unsustainable” means “certainly will not go on like this.” Civilizations collapse when their wicked problems overwhelm them.

No previous civilization faced wicked problems anything like ours, of course, not least because ours are planet-wide, global affairs. Collapse is unlikely to be agreeable, and this time, for most humans, it will not be survivable. The simile I used concerning extreme poverty was not casual. The depth and impact of the planetary crisis depends on the distribution of wealth, not on wealth averaged across the planet. A large proportion of the human population is too impoverished to protect itself against ecological collapse. For them, the collapse will be cruel and widespread, but those of us living high on the hog in the post-industrial world will not be immune. No government, no business – nobody – knows how to

³¹ Meadows D.H., Meadows D.L., & Randers J. (1992) *Beyond the Limits: Global Collapse or a Sustainable Future* Earthscan Ltd. ISBN 978-1853831317

operate in an environment in which natural resources and surplus energy are abruptly and simultaneously declining.

Given the steady growth in our demands on the planet, and the nature of exponential functions, zero population growth will happen soon, and – in historical timescales – suddenly. Zero human population growth is going to happen. Birth rates will one day be no greater than death rates. The question is whether death rates will greatly exceed birth rates, by how much, and for how long.

In the past, civilizations rarely died wholesale in an abrupt Armageddon, but became dysfunctional today a bit here, next year a bit there, in a slow death of a thousand cuts. Our civilization is the first global one, where gargantuan companies do business in every cranny of Earth. Yet we, too, may go out not with a bang but piecemeal. There's good reason to believe that an environment once relatively benign, but now broken under the strain of supporting our species, is already forcing a future on people in many places across the planet.

So the question of the size of budget needed to reach the outcome is no more an issue than is the question of how much it will cost to cut greenhouse gas emissions sufficiently to avoid runaway climate change. You either spend the money and make the effort, or experience what it is to exist on a planet in the throes of a simultaneous water dearth, energy desert, climate turnover, economic collapse, oh and by-the-by, a geologically significant extinction spasm.

And here's what we must do...Almost everyone who read early drafts of this paper said something like, “well, that's all very depressing – and the worst thing is, you don't provide any solutions. People need solutions. Tell us what we should do!” At which point I scratch my head, because I thought I answered that question throughout this paper. To propose a solution for a wicked problem, I said, we have to roll up our sleeves, get our hands dirty, and actually try to solve the problem. What makes you think I have the solution, when the essence of a wicked problem is that it has no “solution”?

At the risk of repeating myself, there are things we can do. Let's start by making sure we have the means to understand and take account of true costs, so that there are no longer any externalities. Let us be sure that our behaviour shows that we understand that this is a single planet on which it is not possible to throw things “away.” That we understand that actions affecting one part of the Earth system affect other parts too; “biodiversity” is not a thing apart. That we understand that while we can learn by doing, every action will teach a different lesson. That we understand that nothing is as simple as it looks, and that complex systems sometimes react in unexpected ways.

Let's elect governments, and especially buy products from companies, that have committed to low ecological footprints and are ready to invest massively in a truly sustainable society. Let's only vote for parties whose leaders are never caught on camera looking cheerful, pleased with themselves or complacent, but only those who permanently look worried to death and who are rapidly going grey. If we absolutely need targets, let them be ones that encourage movement along the road of sustainability. But better than targets, let us establish inspirational visions of an attainable future in which we would like to live, share those visions, and help each other to find ways to live that will cause that dream to come true.

Targets are intended to be reductionist, rational, value-free and quantitative. Evidence of movement towards a target is accumulated deliberately, through systematic, mechanistic experiment and measurement. The data are generated by specialists, who give the measurements legitimacy. Sometimes, but not always, the data are collected in a relatively short time over a wide area.

Understanding how to establish and sustain a balanced relationship between humans and the rest of the living world will certainly need that kind of knowledge. But because all of us must be involved in that relationship, much of the understanding will be generated by the people who use the resources – you, for instance, and me. The legitimacy will come from shared experience about what works in one particular place. It will also require a different kind of knowledge: holistic, partly intuitive, ethical and qualitative, accumulated over a long

time by empirical observations and through learning by doing. And, of course, learning by inquiring. We need to demand the answers to questions like, “where did this meal come from?” “How much fossil fuel went into it?” and “What did it do to the soil?”³²

Let us direct a whole lot more resources towards understanding and the capacity to understand. Not only do we need many more socio-ecologists out there doing anthro-geo-physiological fieldwork, but we also need philosophers and communicators and people who delight in studying and understanding complex, interacting, self-regulating, far-from-chemical-equilibrium, self-organising, ambiguous, borderless systems. Let us learn how to expect the unexpected.

And now I really am repeating myself. What else can I say? Well, perhaps there is one more thing to say, but now I sound discouraging even to my own ears. The evidence suggests that we – our institutions, our businesses, our leaders, our modes of thought, and certainly the way we live our lives – are not reacting, and probably not capable of reacting, nearly as fast as the planet’s climate-biosphere complex is changing. If this is this case, then it is too late for our plague of humans to establish a relationship with the living world that is sustainable on this side of collapse. But for our children’s sake, we should try.

³² Pollan M. (2006) *The omnivore’s dilemma: a natural history of four meals* Penguin Press ISBN 978-1594200823