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Introduction
Biodiversity is the term used to describe the variety of life, at all levels from genes through species and to ecosystems, and is valued by people and cultures for reasons ranging from the aesthetic to the economic. Biodiversity is being lost at increasing rates, largely as a result of human activities. Loss of biodiversity threatens the ecosystems that play a central role in supporting vital Earth systems upon which humanity depends. Ecosystem services are the benefits people obtain from ecosystems through provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual and recreational benefits; and supporting services such as nutrient cycling. Every person in every country depends on these ecosystem services and the biodiversity that underpins them; these links are most direct for the poorest and most vulnerable peoples.

The loss of biodiversity has many consequences beyond the loss of species. A reduction in the diversity of life affects many who value nature for its own sake, but loss of biodiversity may also have serious and hard to reverse direct impacts on human wellbeing. When biodiversity is depleted it can lead to significant ecosystem degradation, reduced productivity and lower resilience.

Increasingly, society is concerned about food and energy security, and the ability of natural and managed ecosystems to respond to environmental change. Biodiversity underpins many key ecosystem functions, including their ability to adapt to change, although the details are often not well understood. The increasing rate of global biodiversity loss necessitates prioritising research and policy interventions that will identify and protect ecosystem function and the biodiversity on which it depends.

Context
The world needs greatly improved biodiversity policies, developed through existing local, national and international systems and structures. There are a number of fundamental principles, developments and concerns which are not incorporated in current policy and management responses:

- Biodiversity and ecosystem services are part of natural capital – distinct from the manufactured capital, knowledge, human and social capital on which most policy decisions are currently based. Natural capital is a public good that is currently often exploited for private gain.
- There is an emerging consensus among the science and policy community on both the necessity of monetary and non-monetary valuations of biodiversity and ecosystem services and methods to be used.
- In addition to its economic value biodiversity has intrinsic cultural values in all societies.
- Biodiversity is managed and valued locally, though the consequences of its alteration and loss may be felt strongly elsewhere..
- Biodiversity and ecosystem services are receiving increased attention under some international conventions and agreements. Ensuring coordination and implementation among these mechanisms presents many challenges. This is important as large and significant components of biodiversity, notably in the oceans, exist in international spaces, outside national governance structures. Some ecosystems

are managed through international agreements or conventions, although their specific management goals may not always benefit biodiversity.

- Science advice to the international mechanisms is sometimes weak and fragmented, especially as mechanisms move away from systems of resource management and extraction, to biodiversity management for multiple benefits.

Current state of knowledge

Knowledge of how biodiversity and ecosystems interact to support ecosystem services is constantly developing and it is not complete, but it is more than sufficient to warrant significant national and international policy changes.

There is now abundant evidence that the biodiversity of an ecosystem determines its ability to deliver a broad range of services. Improving understanding suggests that under environmental change the impacts of biodiversity loss will be more severe than currently observed or forecast. Although the organismal diversity that underpins many key ecosystem services is often poorly known, especially for invertebrates and microbes, it is still possible to make statements about the role of biodiversity by using proxy measures. Some ecosystem services rely more strongly on biomass than on biodiversity, and as these ecosystems undergo environmental changes, the role of biodiversity in these systems could determine their resilience to change. It is not possible to generalise about the importance of biodiversity in sustaining ecosystem services under continuing environmental change, nor whether it is biodiversity at the genetic, species or functional group level will turn out to be most significant.

Not all ecosystem services can be maximised simultaneously: they may depend on different components and structures of biodiversity. Management therefore needs the additional knowledge of complementarities and trade-offs, as well as an understanding of the different outcomes across spatial and temporal scales. Generally management of an ecosystem for a single service (e.g. food, timber) will reduce its capacity to deliver other services. Because human communities depend on biological systems in complex and varied ways, it will be necessary to focus on the key ecosystem services that are most important for human wellbeing.

How biodiversity and ecosystem services are valued is critical for good policy. Different societies and different actors within societies will place distinct values on the various elements of biodiversity but we lack the means to incorporate and reflect this range of views in decision making and policy construction. Even conservative evaluations of natural capital show that, in many developing countries, it has declined per capita more than monetary wealth has risen since 1970. In terms of inclusive wealth per capita, these countries have therefore become poorer, not richer: their natural capital has not been valued sufficiently highly. New applications of economic valuation show that society has taken for granted the contributions from ecosystems and biodiversity; and by not valuing those contributions properly we risk losing them. From a utilitarian perspective some kinds of biodiversity are more valuable than others, and maximising utilitarian benefits has often led to loss of overall biodiversity.

Biodiversity and ecosystem management must take place on many different scales, and there are often conflicts across scales and poorly understood interactions among ecosystem services. The institutional and governance mechanisms required to ensure equitable and fair access and use of biodiversity and ecosystem services are still poorly understood. Some especially important and vulnerable areas have been identified, including boreal and arctic zones, tropical forests, freshwater systems, marine fisheries and soils.

Promising approaches – case studies
Although the knowledge base is still emerging, decisions are being made based on what is known and they are being adopted by public and private sector organisations all over the world. It is important that the implementation of these processes is monitored and evaluated to reinforce the knowledge base. In implementation tradeoffs amongst ecosystem services are common but models that develop a variety of scenarios can aid the decision making process.

Using an ecosystem service approach to biodiversity management can change management priorities. The Boreal regions are not traditionally considered hot-spots for biodiversity but outperform other large biomes in supplying a number of services such as carbon storage, flood control and provision of freshwater providing additional incentives for conservation.

The Antarctic Treaty has illustrated a positive example of ecosystem management and international co-operation for many years. Under the treaty, ecosystem-based management has been implemented as a process of continuous policy elaboration based on sustainable development perspectives to protect interdependent biological systems.

Good examples of ecosystem services and biodiversity management are just starting to emerge, but there are some innovative examples of the ecosystem services approach being used:
- Innovative Public Works programmes aimed at improving ecosystem service delivery while contributing to human well being and poverty alleviation in South Africa demonstrate the value of action. One example is the 'Working for Water' programme which cleared invasive species that were significantly decreasing run-off and provided thousands of jobs for previously unemployed people.
- The 'Valuing the Arc' programme is measuring, valuing and mapping the flow and use of ecosystem services in the Eastern Arc Mountains in Tanzania, a global biodiversity hot-spot. Maps of the net benefits from a number of services – including water provision to 4 million people, carbon storage and pollination of crops – derived from alternative land-use policy scenarios can then be used to inform policy.
- In Colombia, biodiversity and ecosystem service models are being used to inform two policy processes. The Water for Life Water Fund is using models to design an investment portfolio that produces the best possible biodiversity, water yield and water quality returns today, and in the face of climate change. The Ministry of Environment, Mines and Territorial Development is using similar models to decide which permits to grant to the agriculture, oil and gas, mining and transportation sectors based on likely biodiversity and ecosystem service impacts.

Recommendations for policy and decision makers
- The universal problems of biodiversity loss, climate change and ecosystem change, faced by people everywhere, are closely linked and this should be reflected in processes to develop solutions at global to local level.
- Biodiversity and ecosystems are valued and often understood best at local scales. Local knowledge and contexts need to be incorporated.
- Ecosystem services depend on biodiversity but all the goals of biodiversity conservation may not be met by management for ecosystem services, especially where that is directed at small numbers of services over short time scales. Biodiversity conservation must continue to have its own agenda.

- Much biodiversity exists in oceans, polar and other international spaces. Science bodies have the potential to contribute to the management of these for the global good.
- Economists have recently made real advances in valuing biodiversity and ecosystems, including economic valuation, innovative discounting approaches and cost benefit analyse for advising on investment decisions. These new approaches should be developed and brought into the mainstream of economic analysis.
- The information, knowledge and tools available for ecosystem-based policy and decision-making are still developing but sufficient for use in many cases. We encourage wider and bolder implementation of these new ideas. As one example, the Reducing Emissions from Deforestation and Degradation (REDD+) scheme should proceed, taking due caution.
- International science-policy links in biodiversity and ecosystem services need to be strengthened, made relevant, accelerated to address new issues and built on the widest possible knowledge base including indigenous. The creation of the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) is one possible mechanism to achieve these goals.
- Public engagement is essential; scientists and policymakers need to engage with a range of audiences, to understand their viewpoints, to communicate issues better and encourage public participation in biodiversity management. Currently the concepts of biodiversity and ecosystem services and the urgency required for better management are not well understood. Clear communication will enhance understanding between scientists, academics, policymakers and the public.

Recommendations for science
- Encourage the rapid growth and development of the new science needed, including links across the disciplines to deliver science and science policy for sustainable development.
- Develop the science for ecosystem management ("gardening the planet") in order to meet growing demands for food and energy and enhancing the ability of ecosystems to deliver multiple benefits, especially under environmental change and in agricultural, urban, restored and/or novel habitats.
- New metrics are needed in order to evaluate progress towards meeting biodiversity and ecosystem service goals to evaluate trends in drivers, their effects on people and their well being, and as a basis for assessing shadow prices for embedding natural capital into national accounts. Policymakers need metrics to assess progress towards slowing or halting the loss of biodiversity.
- Provide incentives for young scientists working in interdisciplinary projects worldwide. Provide enhanced support for cross-disciplinary collaboration and build a community of scientists that will carry forward the new science over the long term.
- Strengthen regional cooperation on biodiversity research, share and exchange resources and promote integrated management at regional level.

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