58. Communicating biodiversity loss and its link to economics

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Climate change and biodiversity loss are the two most important features of human-driven global environmental change. They are also closely related. Not only are they both direct consequences of human population growth, natural resource consumption and waste, but there are many interrelationships among the actions that will be necessary to address each of them. However, while biodiversity loss attracts a great deal of popular interest, it has not achieved the same degree of political attention as climate change. Biodiversity lacks effective intergovernmental commitments, something that biodiversity scientists regularly lament (Legagneux et al., 2018). Perhaps this is because the causes of biodiversity loss are complex and less clear-cut than are the causes of climate change. While it is clear that moving away from our current carbon-based economy will be difficult, it is much more tangible than the multiple actions across scales and sectors that will be required to reverse biodiversity loss (IPBES, 2019). At least we know what we must do to limit the degree of climate change. But the lack of binding commitments addressing biodiversity loss may also be due to the fact that the immediate consequences of biodiversity loss are neither evident nor obviously material compared to climate change impacts. It is accepted that climate change carries substantial economic costs, and even existential threats. By contrast, the consequences of biodiversity loss are multiple, vague and often contested. While there are very good reasons to be concerned about biodiversity loss and its potential to pose a serious risk to future generations, biodiversity can be perceived as an idle concern for amateur naturalists, or a manageable problem that technological innovation will address as necessary.

The recognition of ecosystem services and their importance for society (Daily, 1997) has to some extent transformed the way in which biodiversity is perceived in policy-making. A developing narrative about the dependence of people on nature, and assessments such as those produced by the Millennium Ecosystem Assessment (MEA, 2005), The Economics of Ecosystems and Biodiversity (TEEB, 2010), and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES,

2019) (see Glossary) have documented the value of nature to people in ever more detail along with growing evidence for the continuing loss of nature. Yet, the economic and existential risks are hard to grasp and even harder to quantify. I have spent the last 30 years researching biodiversity loss and ecosystem change, and this chapter describes the journey that I have taken to measure the rate of loss and unambiguously present the evidence for why it matters to society. I don't have an answer, but I will conclude with some suggestions and current activities that will hopefully improve the situation over the next few years.

BIODIVERSITY ASSESSMENT

Based on an early interest in natural history, and a general enthusiasm for science, I studied zoology as an undergraduate and evolutionary ecology for my PhD. In the 1970s and 1980s, ecological theory was a rapidly moving and an inspiring area of science in which to be involved, building on the great work of Robert MacArthur, Robert May, Edward Wilson and John Maynard Smith among many others. I'm not a good mathematician, but I can follow theory and think conceptually, and I am better than some at organizing data. So, I ended up doing a PhD that was largely statistical and then I went on to study at the Smithsonian Institution in Washington, DC, USA. Here I first encountered research into species conservation. At the time, a large gulf existed between conservation practice and the nascent field of conservation science. The debate about whether protected areas should be single and large, or many and small, and the genetics of small populations dominated the conservation science agenda, and while the theory was developing it had rather little connection to practice and decisions on the ground.

I continued my academic studies in comparative biology but by the mid- to late 1980s the biodiversity crisis was becoming clear. There was much interest in designing conservation programmes at a larger scale to address burgeoning species loss. I found myself to be one of a relatively small group of people actually working on the population biology of species conservation. Michael Soule called this a 'crisis science' and I was among the first members of the Society for Conservation Biology that he and others founded to develop the science to address the crisis.

I struggled with postdoc appointments while small children dominated the rest of my time, and I ended up with several short-term positions working on conservation planning for a wide range of species. I developed conservation plans for everything from gorillas, rhinos and oryx, to snails, bats and ducks, and many others besides. There were many different species in various habitats facing multiple threats, and we were trying to create practical tools to assist managers and funders to focus and prioritize conservation projects. Ultimately,

this work led to what became a long-running project that I ran collaboratively with Simon Stuart of IUCN. This was to develop the international rules that are now used to list species at the highest risk of extinction – the IUCN Red List categories and criteria (IUCN, 2001). We worked through a series of drafts, undertook reviews and consultations, and eventually presented a final version of the system that was ultimately approved by the IUCN Council in 2000. This system has been in place ever since. It is well maintained by IUCN staff working with the wide network of species experts worldwide, and the combination of clear and well-established rules, an effective team maintaining and organizing the data, and a managed expert network provides an authoritative system that documents the growing numbers of threatened species in ever greater detail. The list provides one of a handful of global metrics used to track the state of biodiversity (Butchart et al., 2006, 2010).

I learned a huge amount from being involved with the IUCN and the Red List, working with government and non-government scientists and conservation practitioners, and considering the decision-making process as well as natural science. For the first time, I found myself a target of lobbying. Developing science-based criteria for threatened species turns out to have political consequences because some species are very important to certain groups of people who feel very strongly about whether or not they should be listed as threatened. It was clear that public and personal concern for species was not necessarily closely related to the urgency of conservation action, and some species that were economically important (including marine turtles and Atlantic cod) met the qualifying criteria in the IUCN Red List. The experience taught me a lot about the relationship between science and policy. With support from IUCN, we stuck to the science, but it was clear that in many cases the choice about where to place the boundary between threat categories was a compromise. Somebody was going to disagree with the outcome, and while some differences were due to different levels of risk tolerance, sometimes it was simply a case of pitting one difficult and complex species conservation issue against another.

Around the turn of the millennium the Millennium Ecosystem Assessment (MEA) was being developed. Unlike the IPCC's focus on climate, the MEA had a focus on ecosystems and ecosystem services. Over a five-year period, using assessment processes from the IPCC, the work developed to create a policy-relevant assessment of the state of the world's ecosystems and their ability to continue to support the needs of people into the future. There were many fundamental questions that had to be addressed. How to define and classify ecosystems? What are ecosystem services? How is biodiversity involved in ecosystem services? As well as this, there was a set of fundamental questions about how all this would be important to people. Who are the people that depend upon ecosystems, how should we identify the functions and structures

in ecosystems upon which we depend, and most important of all, what is the value of ecosystem services? What do future generations stand to lose if we continue to allow ecosystems and biodiversity to degrade? Most contentious of all, what is the value of biodiversity?

My role in the MEA was interesting. I was recruited to contribute to the first volume (reviewing the status and trends of ecosystems) because of my work on species for the Red List. I had a broad knowledge of biodiversity and threatened species, and many contacts globally in the conservation world. I was in a great position to be a Coordinating Lead Author for the biodiversity chapter of the MEA and I organized a team of co-authors with access to the best data and knowledge covering many geographic and taxonomic groups. We just needed a clear focus for the chapter. By the time I was signed up to do this, the conceptual work to define ecosystem services had been more or less completed. Ecosystem services were organized into a classification that is still widely used today, with provisioning, regulating, cultural and supporting services all contributing to the benefits that flow to people from ecosystems. My MEA work was to pull together the biodiversity chapter to sit within this scheme. At the first meeting I was asked in which part of the ecosystem services classification I thought biodiversity should be placed. Should I go and work with the food, water and energy people? Would it be better as a regulating service alongside climate and pest regulation, or was it actually a cultural service, meeting some specific needs for societal cohesion and inspiration?

I was baffled by this discussion. To me it was clearly none of these. Ecosystems are defined by the interactions between living (biotic) and non-living (abiotic) components, and so ecosystems don't exist or function without their living components, and their living components are biodiversity. I was not sure at all how biodiversity science should sit in the conceptual framework of the MEA, but I was absolutely sure that biodiversity is not simply another ecosystem service. I argued at the time that it underpinned just about all ecosystem services. While many people wanted biodiversity to be an outcome of good ecosystem services management, I wanted it to be an input to well-functioning ecosystems from which ecosystem services could be expected to flow. Ecologists had long been interested in how diversity was maintained in ecological communities, and what the consequences of changing diversity were for essential functions such as biomass production and decomposition. There was a growing body of evidence that for many services, greater diversity underpinned stronger and more resilient ecosystem services, but that selection for a few top-performing species was key to ecosystem simplification for agriculture, fisheries and forestry (Cardinale et al., 2012). It is this tension that makes the debate about biodiversity loss in a resource-hungry world so complicated. The MEA biodiversity chapter was homeless while we debated this issue, but in the end it was one of the underpinning introductory

chapters along with drivers, human well-being and vulnerable people (Mace et al., 2005).

There were for me a few interesting legacies of the MEA experience and they have persisted in my research over the 15 years since. It was through work on the MEA that I first formally encountered economists. I could see the importance of agreeing how economic valuation of ecosystem services should be undertaken, and what these values might be. But the MEA team as a whole struggled with economics and valuation. There were many different perspectives and approaches, and consensus never developed enough for a clear message to emerge. Heated debates about monetization of ecosystem service benefits focused not only on the methods for doing it but about whether it had any meaning or utility for decisions, and if so whose decisions (and for whose benefit)? While difficult and slightly frustrating I found these economics discussions to be both interesting and important, and it was somewhat frustrating that we could not find a clear role for economics in the MEA.

Second, despite the vagueness of where biodiversity should sit in the MEA, everyone thought it was important and it was always a highlight in any wider discussion or presentation. The headlines about species extinctions were unarguable and attracted a lot of attention. We did a reasonable job of pulling together a coherent global assessment of the data on biodiversity loss and at the launch of the MEA in 2005 it was our figures on extinction rates that grabbed the popular headlines. This was despite the stark warning from the overall assessment that the world was on an unsustainable development trajectory and needed to change course. The clear disconnect in my mind between the data on species extinctions and the evidence for unsustainable patterns of resource use was not apparently a problem for most people, even though it is clear that actions to reduce the former may have little to do with reversing the latter. Interestingly, almost exactly the same happened early in 2019 with the release of the IPBES Global Assessment (IPBES, 2019). Despite the carefully articulated conclusions from IPBES about actions needed to address the severe risks of losing ‘natures’ contributions to people’, the popular headlines featured the million species at risk of extinction over coming decades, and illustrated the work with charismatic tigers, rhinos and elephants. Somehow the message that ecosystems matter materially to people for wider reasons than the loss of charismatic species was lost in popular press reports for both the MEA in 2005 and 15 years later for IPBES.

USING ECONOMIC ARGUMENTS

I encountered several groups of people who really wanted us to say something tangible about the economic value of lost biodiversity. There were various figures around at the time, including the widely cited figure of \$33 trillion

(Costanza et al., 1997), but these seemed to be estimates of the marginal values of ecosystem services, and not easy to relate to biodiversity. Surely biodiversity, the sum of the diversity of life on Earth cannot be accounted for in this way? It is fundamental and its loss would be existential. I think we still struggle to conceptualize the measurement of biodiversity value (see below), but it was clear that there were ways of asking and answering the question about the value of intact nature that were both valid and useful. Andrew Balmford's work (Balmford et al., 2002), for example, had shown how intact ecosystems carried about 100 times the total social value of converted ecosystems across a wide range of ecosystem types. Similarly, there were many case studies emerging that showed how loss of certain biodiversity components would lead to the collapse of ecosystem service benefits, such as pollinators or pest-control species, and even how poor management would reduce the value of benefit flows.

Conservationists, environment policy-makers, natural resource managers and development scientists were all interested in the question of valuation of biodiversity. Yet, we had very few answers, and those that we were able to point to were all very specific, relating to a specific service (for example, pollinators or watershed management) that was difficult to generalize across places and across ecosystems and ecosystem service categories. As a result, it was difficult to construct an overarching economic case for biodiversity.

Nevertheless, it was still clear that there was not a problem communicating the biodiversity crisis. We had plenty of compelling figures and statistics documenting the ongoing loss of species, loss of biota and transformation of ecosystems. Each annual release of the IUCN Red List documented increasing rates of threat among the world's species and attracted headlines in newspapers and on broadcast media. But, slightly alarmingly, this was often the last item in a TV news broadcast and frequently presented as mildly amusing anecdotes, illustrated with a quirky story about the loss of a rare, unusual species. The dusky seaside sparrow and George, the last Hawaiian land snail, have had their 15 minutes of fame as a result. But stark as it is, this narrative is not apparently doing anything to stimulate actions at the scale and intensity needed. Meanwhile, biodiversity scientists were continuing to document the very clear evidence that the intergovernmental commitment made in 2002 to slow the rate of biodiversity loss had demonstrably failed. If anything, the evidence in 2010 was that the rate of loss was still increasing (Butchart et al., 2010) and despite new political commitments made in 2010, the situation is not improving (Green et al., 2019; Tittensor et al., 2014).

The Stern Review, published in 2006, provided a model for the kind of evidence-based analysis needed to support action. Stern's bold approach, to estimate the costs of inaction on climate change, attracted wide attention and, coming from a credible and authoritative economist, its message reached into

the highest reaches of government and corporations. TEEB (2010), set up to mirror the Stern Review, was influential for business and government, but other than making the roles of ecosystem services clearer, it did not transform the seriousness of commitments made towards biodiversity at any level.

Following the global MEA, the UK government's Environment Department (Defra), undertook an ecosystem assessment in the UK. This ambitious project was ably led by Bob Watson who was then the Chief Scientific Adviser in Defra. He had wide experience of assessments from working on the IPCC and MEA. The UK National Ecosystem Assessment (UKNEA, 2011) was a two-year project to assess the state of ecosystems and ecosystem services in the UK, and their ability to support the needs of people into the future. At the very first meeting of the expert group I sat next to Ian Bateman, an environmental economist who had been recruited to the project by Bob Watson. It took no time for he and I to agree that the UK was the perfect case study to use to trial a full economic analysis of the costs and benefits of ecosystems and biodiversity. We worked together on a conceptual framework for the assessment that would improve the comprehensiveness of ecosystem service valuations (Mace and Bateman, 2011), and he recruited a team of economists to work across the different components of the work to ensure that this consistent approach was followed. Needless to say, it was not straightforward. But we did manage to map and value multiple ecosystem services at national scale and show the importance of non-market services, especially recreational values and carbon values. Market values, mainly from food production, once the effects of subsidies were removed, actually had remarkably low welfare values. Managing the UK landscape for the full suite of ecosystem services could therefore be shown to increase the social welfare value almost 100 times. Of course, there is a practical problem with this finding in that there are no mechanisms to pay landowners for these services. But the headline result remains valid and the outcome was I think a marked improvement over earlier attempts. We wrote this up for a paper published in 2013 that showed clearly that the value of UK ecosystem services was substantial but lay almost entirely outside market mechanisms (Bateman et al., 2013).

The UKNEA also did not treat biodiversity as an ecosystem service and the approach we took for economic analysis was to lay out alternative scenarios for ecosystem management and then compare both the total social value of ecosystem services alongside a measure of biodiversity conservation (bird species richness). Our models showed clearly, and not surprisingly, that land management strategies that maximized the social value of ecosystem services were almost optimal (not quite) for biodiversity conservation. So, in a situation where ecosystem services are taken seriously in land use decisions there will be almost no opportunity cost from biodiversity conservation. The problem is that land use decisions that maximize market values (food production almost

entirely) has a substantial cost for both ecosystem services and biodiversity conservation. There are parallels in other contexts where enlightened political decisions recognize not only the limits of valuation, but also the risks of taking them too seriously (Box 58.1).

BOX 58.1 PRIME MINISTER ROCARD ON HOW TO EVALUATE AN ECOSYSTEM (CONTRIBUTED BY CLAUDE HENRY)

At the end of the 1980s, there was an advanced project to build a dam on the upper course of the Loire, in the middle of a long canyon known as les Gorges de la Loire, with the objective of, it was claimed, regulating the flows downstream. I was asked to build a multidisciplinary and international team (not a frequent assemblage in France at the time) of experts: Welsh and Dutch ecologists, French and English economists and hydrologists, and the well-known English landscape architect Jeremy Purseglove. We quantified in monetary terms things like damages from potential floods, incomes from agriculture and tourism that were at stake, and so on. Potential losses of biodiversity were carefully evaluated, albeit not translated into monetary evaluations. And Jeremy made eloquent drawings, with comments for interpretation, pre- and post-project, without any reference to economic values.

A report was written, bilingual, and a meeting was organized at Matignon, the residence of the Prime Minister. Rocard was a macroeconomist by training, and an imaginative maverick in politics. He enjoyed the discussion on the report, and then concluded: 'It is a comprehensive and serious piece of work, made possible by the diversity of expertises and cultures in the team. I am particularly happy that you didn't try to foul me by pretending that every aspect is susceptible to be valued in monetary terms. It would have been misleading and in any case we don't need it; it is my responsibility to make an overall assessment'. Soon he killed the project.

The UKNEA certainly attracted attention in government, as well as in business and industry. The UK government White Paper in 2011, 'The Natural Choice', drew heavily on the work. It stated:

The Government wants this to be the first generation to leave the natural environment of England in a better state than it inherited. To achieve so much means taking action across sectors rather than treating environmental concerns in isolation. It requires us all to put the value of nature at the heart of our decision-making – in Government, local communities and businesses. In this way we will improve the quality and increase the value of the natural environment across England.

The White Paper also called for the creation of a Natural Capital Committee (NCC) that would put nature at the heart of decision-making in government and advise how to achieve this ambition to be the first generation to leave the environment in a better state.

As a member of the NCC, I was surrounded by economists of various kinds, including people with a primary interest in environmental economics but also interested in energy economics and corporate accounting. It was an extremely interesting committee and we had many lively debates about how to value and measure natural capital, including biodiversity. The NCC itself also became quite controversial; to many people, even putting a value to nature devalues it. According to *The Guardian* journalist George Monbiot, for example, nature should be beyond valuation. Or, for some people, it seemed that the interest in valuing nature being taken by the UK government was simply a prelude to selling off large tracts of forested land. Certain journalists and lobby groups alike were aghast at the work of the NCC. My own view, which I tried to explain repeatedly was that we were interested in putting a value to nature so that it could be taken seriously and invested in. We were not trying to reduce it to a marketable commodity, far from it in fact. The more I worked in the NCC, the more two overarching conclusions became clear to me. First, that broad-sense biodiversity, the diversity of life, is beyond valuation. Its roles are so fundamental and foundational that any attempt to value it is ultimately meaningless. In effect, it is of infinite value and its loss ultimately creates an existential risk, even if we are quite a long way from realizing this risk. However, there are many useful approaches to valuing nature's services or ecosystem services, the flow of benefits from which people derive health, well-being and fulfilling lives. These methods are easier for some kinds of services than others, but the more comprehensive we can be, the better because there are many win-wins in the area of ecosystem service management. There are some win-loses too – unfortunately, very often related to provisioning services or ecosystem services whereby energy and matter are removed from the ecosystem and used or transformed. Mapping, quantifying and modelling these ecosystem services locally is the science-based information needed for land management decisions, and the tools and techniques for doing this are increasingly widely available and useful. However, the sum of these values will always be a substantial underestimate of the value of nature.

A corollary of this is that ecosystems and biodiversity can usefully be considered a capital stock. So, in accounting terms, a balance sheet approach is appropriate. Ecosystems, including their biodiversity components, are assets whose condition can be measured, at least in physical terms, and this should not deteriorate over time unless for some reason a decision is made to abandon the asset. Investing in ecosystems will generally lead to an improved flow of ecosystem services, so valuing the services is one way to ensure that the

ecosystem itself is being well managed. However, the sum of the value of the services is not necessarily a good indicator of the state of the asset because certain high monetary value services might dominate, at least transiently, but the ecosystem itself may be unsustainable. Apparently comprehensive valuations of all ecosystem services that an ecosystem supplies are always likely to be an underestimate of ecosystem value because of services we cannot measure or do not (yet) use.

CONCLUSIONS

There is no single answer to the question of how to value biodiversity, or how to communicate the societal consequences of ongoing biodiversity loss. There are multiple perceptions of how and why biodiversity loss matters, and few shared approaches to its valuation. Economic valuation is one of the approaches that I think is a necessary part of the solution, but it is far from being sufficient. Valuation is useful to show that biodiversity loss has material consequences and that it plays a significant role in the economy and should therefore be afforded serious consideration alongside health, infrastructure, education, justice and other essential societal concerns. I support the idea of including the natural environment and biodiversity in national accounts, although there is much work to be done to ensure this is done well (Bright et al., 2019; Mace, 2019). But the complexity and scope of biodiversity means that the values are going to be partial, inaccurate and very likely large underestimates. There is a risk that the values are easily contested and can underplay the irreplaceability of nature.

In fact, many people feel that using valuation diminishes nature by commodifying it. The moral commitment to saving species is most often applied to charismatic megafauna, such as the great whales, elephants and tigers, but in principle applies to all of life on Earth. The cultural values of biodiversity are unarguable and nearly always gather wide support, demonstrated very recently by substantial shifts in people's attitudes to plastic waste brought about by compelling images of its direct impact on ocean wildlife in a David Attenborough documentary. But these cultural values are societally driven and as such are changeable and heterogeneous, requiring a much more sophisticated approach to establishing relational values relevant to different groups of people (Pascual et al., 2017).

Despite these difficulties, the ecosystem services approach and effective policy and public communication of biodiversity loss have certainly enhanced the degree to which it is perceived to be a serious problem over the past 20 years. Biodiversity loss is now seen to be a global challenge equivalent to climate change. However, methods for communicating it, and for acting on its consequences still lag behind, and there is plenty to do. A clearer appre-

ciation of the underpinning roles of biodiversity, including for achieving the Sustainable Development Goals, or for addressing the nexus of environmental issues such as food and energy security in a changing climate, will become increasingly important.

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Glossary of abbreviations in the text

IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. An independent intergovernmental body, established by UN member states in 2012 (www.ipbes.net)
IPCC	Intergovernmental Panel on Climate Change. Under the UN Framework Convention on Climate Change, the IPCC provides policy-makers with regular scientific assessments on climate change, its implications and potential future risks (www.ipcc.net)
IUCN	The International Union for Conservation of Nature. A membership union composed of both government and civil society organizations (www.iucn.org)
MEA	Millennium Ecosystem Assessment. An assessment of the consequences of ecosystem change for human well-being called for by the United Nations Secretary-General Kofi Annan in 2000. From 2001 to 2005, the MEA involved the work of more than 1360 experts worldwide (www.millenniumassessment.org)
TEEB	The Economics of Ecosystems and Biodiversity was a study led by Pavan Sukhdev from 2007 to 2011. It continues as an international initiative to draw attention to the global economic benefits of biodiversity (www.teebweb.org)