VALUING NATURE

Description of the Action: Why value nature? Degradation of ecosystems, the services they provide and the over-exploitation of natural resources have been widely documented in terrestrial, freshwater and marine systems. This has occurred in large part because many ecosystem services have no immediate market value hence their wider societal value is frequently under-estimated or entirely over-looked in decision-making. The Millennium Ecosystem Assessment (MA)[1] in 2005 highlighted the need to better recognise the values and benefits people derive from ecosystems by bringing together existing knowledge. Recently the UK National Ecosystem Assessment (NEA) published a comprehensive assessment of the services provided by UK ecosystems[2]. This work developed a novel conceptual framework for linking ecosystem services and human well-being through a more comprehensive quantification of the values people receive than had been attempted previously. This work clearly showed that taking into account the values of services for which there is no market would profoundly alter policies regarding land-use. The NEA has had a major impact on UK environment policy, playing a key role in shaping the recent Natural Environment and Water White Papers, and directly leading to the establishment of the Natural Capital Committee, which reports to the Treasury on the state of natural capital and ecosystem services in the UK. There have also been significant developments in this area internationally with the establishment of the Inter-Governmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES)[3], which is designed to play an analogous role to the IPCC in the area of biodiversity, ecosystem services and human well-being.

Despite the rapidly growing importance of valuing nature in the policy arena, significant scientific challenges remain in this area. The major challenge concerns how to represent the complexities of the natural environment in valuation analyses. Addressing this challenge has been hampered by the lack of a genuinely inter-disciplinary research community capable of working across the natural and social sciences, and the humanities. In recognition of this, NERC led the establishment of the Valuing Nature Network (VNN)[4] early in 2011. The goals of VNN were to: (1) facilitate the development of an inter-disciplinary research community well-connected with end-users and with the capacity to undertake world-leading valuation work; and (2) identify the key research issues that need to be addressed going forward. These goals have been fulfilled (details below). When VNN was established it was recognised that once a research community and associated agenda had been developed (Phase 1) there would be a need for a research programme that supported valuation (Phase 2). This action sets out the case for that programme.

Two important research areas that have emerged from VNN's work are: (1) the relationships between ecosystem stocks and services, the identification of so-called 'tipping points' and the links with valuation and natural capital accounting; and (2) the relationships between ecosystems and human health. In broad terms, an ecosystem service is the *flow* of biomass, energy or nutrients from an ecosystem that affects human well-being. Ecosystem *stocks* are the key interacting biological components of an ecosystem that regulate these flows or services. Ecosystem stocks are often referred to as *natural capital* because they play an analogous role to financial capital in an economy. There are important feedbacks between ecosystem stocks and services. If the exploitation of a service increases, stocks often decline, reducing the capacity of the stock to support service flows in the future. Stock depletion can reach a point where there is an abrupt decline in service flows i.e. a 'tipping point'. A number of marine fisheries show this type of pattern - as fishing mortality increases (i.e. as the exploitation of the ecosystem service increases), fish stocks can decline to the point at which catches collapse[5]. Stock recovery can then take a very long time[6]. With the exception of these well studied examples, our understanding of the relationships between stocks and services is patchy but significantly improving. Over the last 5 years or so, NERC-funded (e.g. BESS, Insect Pollinators Initiative, MarineEcosystems) and other

[1] Millennium Ecosystem Assessment. 2005. *Ecosystems and human well-being: Synthesis.* Washington D.C., Island Press.
[2] UK National Ecosystem Assessment. 2011. Synthesis of the key findings. DEFRA.
[3] www.ipbes.net
[4] www.valuing-nature.net
[5] Cook, R.M. et al. (1997) Potential collapse of North Sea cod stocks. Nature 385, 521.
[6] Hutchings, J.A. (2000) Collapse and recovery of marine fishes. Nature 406, 882.

programmes (e.g. FP7, BIODIVERSA) have begun generating data on ecosystem stocks and services that can be used to define tipping points. This provides an opportunity to significantly develop our understanding in this area, but addressing if, when and how society should respond to declining ecosystem stocks goes beyond the environmental sciences. This is because we need to be able to understand how the values of services are changing as stocks decline, and feed this valuation into a cost-benefit analysis of various response options. It would then be possible to define stock (natural capital) levels that would avoid abrupt and damaging changes in services, and monitor these going forwards through natural capital accounts. Although the economic techniques are available for valuation and cost-benefit analysis, progress is hampered by a lack of funding support for the inter-disciplinary studies needed to tackle these issues.

It is becoming increasingly apparent that ecosystems play an important role in human health that goes beyond the effects of environmental pollutants. For example, natural hazards and extreme events have negative effects on physical and mental health[7]; biodiversity can affect health through exposure to diseases or toxins[8]; and biodiversity and ecosystems can improve health through changes in the aesthetic, cultural and recreational attributes of natural systems[9]. In the language of ecosystem services, negative health effects frequently arise because ecosystems fail to regulate natural hazards or diseases to some extent; whereas positive effects arise because ecosystems provide a range of cultural services that are important for well-being and hence health. Despite this potential importance, we still know comparatively little about the key ecosystem dynamics that affect health outcomes, the role biodiversity plays in these, how these dynamics are responding to environmental change, and how ecosystem management might improve health outcomes. Addressing these issues could have significant impact. Department of Health figures estimate that poor mental health, for example, costs the UK economy £145 billion per annum in healthcare, benefits and lost productivity. Even if improved ecosystem management reduced only a fraction of these costs, the economic benefits of the research could be substantial.

The aim of the proposed action is to address these research challenges, whilst at the same time further developing inter-disciplinary research capacity. The proposed action has three main goals:

(1) To improve our understanding of (i) the links between ecosystem stocks and tipping points, (ii) how the values of ecosystem services change as tipping points are reached and exceeded, and (iii) critical levels of natural capital that avoid abrupt and damaging ecosystem change.

(2) To improve our understanding of the roles ecosystems play in human health.

(3) To continue to provide time-limited support to the VNN.

Goal 1 will be addressed by building upon recent or existing programmes that are already generating relevant information on the relationships between ecosystem stocks and services. Additional work will be done based around this knowledge to define tipping points, and link these with valuation and other analyses to identify critical levels of natural capital. Goal 2 focuses specifically on the role of biodiversity and ecosystem processes in three areas: (i) natural hazards and extreme events, (ii) the exposure of people to vector-borne diseases and marine toxins, and (iii) health improvements associated with urban ecosystems (green space). There is a need in all of these areas to better understand the ecosystem dynamics that affect health outcomes, how these are changing and how they might be managed. They are priority areas for the UK health agencies (Health Protection Agency [HPA], Dept of Health [DH]), and areas (i) and (iii) provide an opportunity to address mental as well as physical health outcomes. Goal 3 is designed to provide continued support for the VNN community through a series of activities (website, communications, training courses and workshops) designed to facilitate knowledge exchange, proposal development, and the application/use of the developing science. This is an extension of the current

[7] Alderman, K. et al. (2012) Floods and human health: a systematic review. Environmental International 47, 37; Stanke, C. et al. (2012) The effects of flooding on mental health: outcomes and recommendations from a review of the literature. PLoS Currents Disasters 4.
[8] Keesing, F. et al. (2010) Impacts of biodiversity on the emergence and transmission of infectious diseases. Nature 468, 647; Chambouvet, A. et al. (2008) Control of toxic marine dinoflagellate blooms by serial parasitic killers. Science 322, 1254.
[9] Lee, A.C.K. & Maheswaran, R. (2011) The health benefits of urban green spaces: a review of the evidence. Journal of Public Health 33, 212.

activities being undertaken by VNN. Support for networking activities by NERC should be time-limited and that eventually VNN should be self-sustaining. An exit strategy is set out below.

Existing investments and National Capability needs: VNN was originally established to build inter-disciplinary research capacity because it was recognised that this capacity was almost entirely lacking. VNN was proposed jointly by the BIO and SUNR Themes because valuation of biodiversity, ecosystem services and natural resources is a strategic research challenge for each theme. NERC has invested nearly £700K in the VNN since 2011. Whilst the major Network activities finished in Spring 2013, additional funding was provided to maintain the Networks web activities until end November 2013. . To date, VNN has over 1000 members and has engaged widely with the policy (e.g. DEFRA, H.M. Treasury, DECC), business (e.g. Shell, Deloitte, various utilities companies) and NGO (e.g. RSPB) communities. VNN has leveraged an additional £400k from DEFRA and business to fund project-related activities. There are opportunities to exploit previous capacity building programmes (e.g. *Environment and Human Health*) and link with current programmes (*Flooding from intense rainfall*).

Action investments: A 5-year, £5M investment from NERC is proposed to support the goals of this action. This a cross-theme action led by the Biodiversity Theme and including Natural Hazards and Environment, Pollution and Human Health reflecting the fact that the action spans NERC's strategic interests. Funding for Goal 1 would support discipline-hopping fellowships to enable environmental scientists with a background in ecosystem sciences to extend their expertise into valuation and natural capital accounting. These fellowships would build upon recent or existing programmes that are generating data on the relationships between ecosystem stocks and services. Funding for Goal 2 would support inter-disciplinary projects that address the priority areas identified above. Funding for Goal 3 would support a team and the associated activities necessary to run the Network for a further 5 years (details above). During the next 5 years a plan would be developed to make the Network self-supporting beyond the lifetime of NERC funding. Funding to support all Programme Goals will be distributed through open competition.

A number of potential partners have indicated co-funding for the action. Possibilities for partnership are strong[10], but are most likely to coalesce after rather than before NERC funding is in place. This view is based on past experience.

Impact: There are three main pathways to impact for this action. First, NERC's initial investment has already helped VNN establish itself as the major hub for valuation science and its use. Maintaining VNN's activities for a further 5 years alongside a significant investment in valuation science, plus developing a plan for sustaining VNN's work in the longer-term, provides an important mechanism for ensuring the impact of the proposed action. Second, Goal 2 was co-designed with the health agencies (HPA, DH) who have indicated a willingness to work with the programme to facilitate research into use. Third, Goal 1 is closely aligned with the work of the Natural Capital Committee, and so could provide important evidence to support the development and use of natural capital accounts in the UK.

[10] This view is based on a partnership meeting held in September 2012 involving RCs (ESRC, BBSRC, AHRC), DEFRA, Wellcome Trust, Business Council for Sustainable Development, Department for Transport, Ecosystems Markets Task Force, Environment Agency, Forestry Commission, Institute of Chartered Accountants, NFU, RCUK Energy Programme, RSPB, Welsh Government.