The "ecosystem services" approach and the Nature Directives

This submission builds on the UK NGO Fitness Check evidence already submitted, particularly in response to questions **Y.1** and **Y.6**.[1]

1. Executive Summary

Although the idea of a positive relationship between nature and human well-being has been around for centuries, it has attracted increasing attention in recent years under the banner of ecosystem services, particularly since the publication of the Millennium Ecosystem Assessment in 2005.[2] In simple terms, ecosystem services can be defined as the outputs of ecosystems from which people derive benefits.[3] However, these outputs depend on a range of complex underlying ecosystem processes and functions that operate across a range of spatial and temporal scales, which in turn are influenced by the way in which humans manage the land and sea. From a policy perspective, the 'ecosystem services' approach seeks to incorporate into decision-making the value of these benefits provided to people by the natural world. In theory, greater recognition of the range of benefits that nature provides can help complement existing biodiversity policies by increasing support for conservation and leading to an improved understanding of how the socio-economic benefits of conservation can be maintained, shared, and enhanced.[4]

However, this 'new' understanding has led some to question whether a more 'modern' approach focussed on ecosystem service provision might be used to replace existing conservation policies focussed on biodiversity. What this might look like in practice is unclear. However, in the context of the Fitness Check of the Nature Directives it is important to consider the extent to which such an approach could deliver on the Directives' overarching objective to maintain and restore biodiversity through the conservation of Europe's threatened habitats and species. Can we assume that an approach that seeks to optimise the provision of ecosystem services will also deliver on these objectives and, if not, what might the implications be for biodiversity and human well-being? Our key conclusions are highlighted below:

- Biodiversity is central to maintaining multiple ecosystem services and plays a critical 'insurance' role in relation to ecosystem resilience and the stable provision of multiple ecosystem services over time, particularly in the face of environmental change. However, as a result of 'market failure' it is frequently undervalued and overexploited.

- There are well-documented trade-offs between biodiversity and certain ecosystem services; when ecosystems are managed principally for the delivery of a single service or a small number of services (in particular provisioning services for which market prices exist), biodiversity is nearly always affected negatively. The assumption that focusing on ecosystem service provision will automatically deliver on biodiversity conservation objectives is thus fundamentally flawed.

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[1] http://www.wcl.org.uk/habsregs.asp

[2] Braat, L. C., & de Groot, R. (2012). The ecosystem services agenda: bridging the worlds of natural science and economics, conservation and development, and public and private policy. *Ecosystem Services*, *1*(1), 4-15; Gómez-Baggethun et al. (2010). The history of ecosystem services in economic theory and practice: from early notions to markets and payment schemes. *Ecological Economics*, *69*(6), 1209-1218.

[3] Guerry et al. (2015). Natural capital and ecosystem services informing decisions: From promise to practice. *Proceedings of the National Academy of Sciences*, *112*(24), 7348-7355.

[4] McCarthy, D. & Morling, P. (2014). *A Guidance Manual for Assessing Ecosystem Services at Natura 2000 Sites*. Produced as part of the Natura People project, part financed by the European Regional Development Fund (ERDF) through the INTERREG IV A 2 Mers Seas Zeeën Crossborder Programme 2007-2013. Royal Society for the Protection of Birds: Sandy, Bedfordshire.

- Individual species are fundamental components of ecosystems and are at the heart of the concept of biodiversity. The loss of both common and rare species can disrupt/impair ecosystem functioning and ecosystem service delivery.

- Many uncertainties and knowledge gaps exist in relation to the complex relationship between biodiversity and ecosystem services and the way to manage and govern those relationships. Scientific understanding of the long-term consequences of biodiversity loss for ecosystem service provision is limited. A ‘safe’ level of biodiversity loss cannot be defined based on current knowledge.

- The potential for abrupt and persistent/irreversible changes to ecosystems and the services they provide occurring as a result of biodiversity loss makes a precautionary approach to conservation essential. In this context, the Nature Directives take a sensible ‘no regrets’ approach to conserving threatened species and habitats (i.e. stocks of ‘natural capital’) and thus plays a key role in supporting the sustainable provision of a broad range of ecosystem services.

- Accounting for the value of the full range of services provided by ecosystems and the synergies/trade-offs between them is extremely challenging if not impossible, particularly in relation to non-use values. An ‘ecosystem services’ approach on its own is highly unlikely to ensure that societal preferences for biodiversity conservation based on its *intrinsic* and/or *instrumental* value are met.

In summary, the ‘ecosystem services’ approach on its own is poorly equipped for ensuring that biodiversity – both for its own sake and for its role in underpinning human well-being – is not overlooked or undervalued, particularly when it comes to conserving threatened species and habitats. If we are to achieve the EU’s biodiversity policy objectives (i.e. to halt and reverse the loss of biodiversity) and ensure the sustainable provision of ecosystem services for both current and future generations, dedicated policies targeting the conservation of species and habitats (i.e. the Nature Directives) will continue to be required for the foreseeable future.

Beyond the Nature Directives, there are a wide range of other EU policies that impact significantly on biodiversity and ecosystem services, but many (e.g. the Common Agricultural Policy) fail to adequately take these impacts into account. There remains significant scope for improving the integration of biodiversity and ecosystem services into such policies; this could both enhance societal well-being and deliver significant conservation benefits.

2. Evidence

At the outset, it is worth noting that *biodiversity* and *ecosystem services* are both complex concepts; there is no single measure or approach that can adequately represent the full spectrum of biodiversity or ecosystem services.[5] This complexity has important implications when it comes to considering the extent to which an approach focused on optimising ecosystem service provision is an appropriate substitute for existing biodiversity conservation policies.[6] In the case of biodiversity, it is defined by the Convention on Biological Diversity (CBD) as *“the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species*

[5] Reyers et al. (2012). Finding common ground for biodiversity and ecosystem services. *BioScience*, *62*(5), 503-507

[6] Barnaud, C., & Antona, M. (2014). Deconstructing ecosystem services: Uncertainties and controversies around a socially constructed concept. *Geoforum, 56*, 113-123; Mace et al. (2012). Biodiversity and ecosystem services: a multilayered relationship. *Trends in ecology & evolution, 27*(1), 19-26; Reyers et al. (2012). Finding common ground for biodiversity and ecosystem services. *BioScience, 62*(5), 503-507; Seppelt et al. (2011). A quantitative review of ecosystem service studies: approaches, shortcomings and the road ahead. *Journal of Applied Ecology, 48*(3), 630-636.

and of ecosystems".[7] Alongside the components of biodiversity, this definition thus particularly emphasises the importance of variability as a key attribute of the concept of biodiversity.[8] Similarly, the relationship between biodiversity, ecosystem functioning, and ecosystem services is complex and multi-layered. Ecosystem services are generated from numerous interactions occurring in intricate living systems over a range of spatial and temporal scales (not to mention the complexity of the socio-economic systems within which they interact).[9]

Broadly speaking, the evidence suggests that biodiversity, measured in a variety of different ways, underpins all ecosystem services and is a key component of multifunctional ecosystems*;* managing ecosystems to provide multiple services thus requires management measures that support a wide range of biodiversity groups.[10] However, there are also well-documented trade-offs between biodiversity conservation and the short-term provision of a number of ecosystem services, although most ecosystems are capable of delivering a range of different services, when ecosystems are managed principally for the delivery of a single service (or a small number of services) biodiversity is nearly always affected negatively.[11,12] For example, in the case of pollination services, only a limited subset of all known bee species are thought to be important for crop pollination, such that an exclusive focus on crop production (as a provisioning service) would not lead to the conservation of many threatened bee species.[13] These findings lie at the heart of the considerable governance challenges that the 'ecosystem services' approach still faces in practice, particularly where local stakeholder(s) have a private interest in particular provisioning services.[14] As highlighted by the UK National Ecosystem Assessment (UKNEA, 2011), the approach to managing most UK ecosystems to date has been to maximise the production of those outputs for which market prices exist (e.g. agricultural outputs) to the detriment of biodiversity and many other services that are equally if not more valuable but for which many of the benefits are non-market public goods.[15] In the absence of

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[7] Helm, D., & Hepburn, C. (2012). The economic analysis of biodiversity: an assessment. *Oxford Review of Economic Policy*, *28*(1), 1-21.

[8] Mace et al. (2012). Biodiversity and ecosystem services: a multilayered relationship. *Trends in ecology & evolution*, *27*(1), 19-26

[9] Cardinale et al. (2012). Biodiversity loss and its impact on humanity. *Nature*, *486*(7401), 59-67; Harrison et al. (2014). Linkages between biodiversity attributes and ecosystem services: A systematic review. *Ecosystem Services*, *9*, 191-203; Mace et al. (2012). Biodiversity and ecosystem services: a multilayered relationship. *Trends in ecology & evolution*, *27*(1), 19-26; Norgaard, R. B. (2010). Ecosystem services: From eye-opening metaphor to complexity blinder. *Ecological economics*, *69*(6), 1219-1227.

[10] Cardinale et al. (2012). Biodiversity loss and its impact on humanity. *Nature*, *486*(7401), 59-67; Hails, R. S., & Ormerod, S. J. (2013). Editorial: ecological science for ecosystem services and the stewardship of natural capital. *Journal of Applied Ecology*, *50*(4), 807-810; Mace et al. (2012). Biodiversity and ecosystem services: a multilayered relationship. *Trends in ecology & evolution*, *27*(1), 19-26 Norris et al. (2011). 4. Biodiversity in the Context of Ecosystem Services. In: The UK National Ecosystem Assessment Technical Report. UK National Ecosystem Assessment, UNEP-WCMC, Cambridge.

[11] Lawton et al. (2010). Making Space for Nature: a Review of England's Wildlife Sites and Ecological Network. *Report to DEFRA*.

[12] Howe et al. (2014). Creating win-wins from trade-offs? Ecosystem services for human well-being: A meta-analysis of ecosystem service trade-offs and synergies in the real world. *Global Environmental Change*, *28*, 263-275; Maes et al. (2012). Synergies and trade-offs between ecosystem service supply, biodiversity, and habitat conservation status in Europe. *Biological conservation*, *155*, 1-12; Reyers et al. (2012). Finding common ground for biodiversity and ecosystem services. *BioScience*, *62*(5), 503-507; TEEB. (2010). The Economics of Ecosystems and Biodiversity Ecological and Economic Foundations. Edited by Pushpam Kumar. Earthscan, London and Washington; UK National Ecosystem Assessment. (2011). The UK National Ecosystem Assessment: Technical Report. UNEP-WCMC, Cambridge.

[13] Kleijn et al. (2015). Delivery of crop pollination services is an insufficient argument for wild pollinator conservation. *Nature communications*, *6*.

[14] Adams, W. M. (2014). The value of valuing nature. *Science*, *346*(6209), 549-551; Bennett et al. (2009). Understanding relationships among multiple ecosystem services. *Ecology letters*, *12*(12), 1394-1404; Guerry et al. (2015). Natural capital and ecosystem services informing decisions: From promise to practice. *Proceedings of the National Academy of Sciences*, *112*(24), 7348-7355; Howe et al. (2014). Creating win-wins from trade-offs? Ecosystem services for human well-being: A meta-analysis of ecosystem service trade-offs and synergies in the real world. *Global Environmental Change*, *28*, 263-275.

[15] Helm, D., & Hepburn, C. (2012). The economic analysis of biodiversity: an assessment. *Oxford Review of Economic Policy*, *28*(1), 1-21; Muradian, R., & Rival, L. (2012). Between markets and hierarchies: the challenge of governing ecosystem services. *Ecosystem Services*, *1*(1), 93-100.

dedicated policies to correct these market failures, the result is a situation in which maximising the short-term provision of a few of the most valuable services (i.e. those that have high market values) takes precedence to the detriment of biodiversity and 'bundles' of other ecosystem services.[16] Of course, that is not to say that so-called 'win-win' outcomes are not possible, particularly where multiple ecosystem services are accounted for; it is simply to state that trade-offs also exist and that an approach focused solely on ecosystem services may inhibit our ability to halt and reverse the loss of biodiversity.[17]

Biodiversity ultimately plays a key role in the sustainable provision of all ecosystem services by enhancing the stability of ecosystems, buffering ecosystem processes against temporal or spatial perturbation.[18] As biodiversity is lost from an ecosystem, evidence suggests that service provision is not only likely to decrease but may also get more variable in space or time. As a result, biodiversity has a potentially critical 'insurance' role to play in relation to ecosystem resilience and the stable provision of multiple ecosystem services through time, particularly in the face of environmental change.[19] As highlighted by Naeem et al. (2012), "*The chief contribution of research on biodiversity and ecosystem functioning has been to articulate, and provide compelling scientific support for, the idea that maintaining a high proportion of biological diversity leads to efficient and stable levels of ecosystem functioning.*"[20] However, as described below, these long-term consequences are not always immediately obvious and can thus be difficult to predict or account for in decision-making.

When it comes to individual species, as well as being key targets for conservation action they are fundamental components of ecosystems and are at the heart of the concept of biodiversity.[21] There is a large body of evidence demonstrating the importance of the linkages between particular species (both common and rare) and a range of ecosystem services. [22] For example, many higher plants and animals which are the subject of dedicated conservation action are known to play a particularly important role in relation to cultural ecosystem services. [23] In relation to ecosystem stability, evidence suggests that even rare species can play an important role in providing long-term 'ecological insurance', and that the loss of such species from even very biodiverse communities

[16] Adams, W. M. (2014). The value of valuing nature. *Science*, *346*(6209), 549-551; UK National Ecosystem Assessment. (2011). The UK National Ecosystem Assessment: Technical Report. UNEP-WCMC, Cambridge; TEEB. (2010). The Economics of Ecosystems and Biodiversity Ecological and Economic Foundations. Edited by Pushpam Kumar. Earthscan, London and Washington.

[17] Cimon-Morin et al. (2013). Fostering synergies between ecosystem services and biodiversity in conservation planning: A review. *Biological Conservation*, *166*, 144-154.

[18] Hooper et al. (2005) Effects of biodiversity on ecosystem functioning: A consensus of current knowledge. *Ecological Monographs*, **75**, 3–35. Loreau, M., & Mazancourt, C. (2013). Biodiversity and ecosystem stability: a synthesis of underlying mechanisms. *Ecology letters*, *16*(s1), 106-115; Loreau et al. (2003). Biodiversity as spatial insurance in heterogeneous landscapes. *Proceedings Of The National Academy Of Sciences Of The United States Of America*, **100**, 12765–12770; Loreau et al. (2001). Biodiversity and ecosystem functioning: current knowledge and future challenges. *Science*, *294*(5543), 804-808.UK National Ecosystem Assessment. (2011). The UK National Ecosystem Assessment: Technical Report. UNEP-WCMC, Cambridge.

[19] Science for Environment Policy. (2015). *Ecosystem Services and the Environment.* In-depth Report 11 produced for the European Commission, DG Environment by the Science Communication Unit, UWE, Bristol; Baumgärtner, S., & Strunz, S. (2014). The economic insurance value of ecosystem resilience. *Ecological Economics*, *101*, 21-32; Elmqvist et al. (2003). Response diversity, ecosystem change, and resilience.*Frontiers in Ecology and the Environment*, *1*(9), 488-494; Mace et al. (2012). Biodiversity and ecosystem services: a multilayered relationship. *Trends in ecology & evolution*, *27*(1), 19-26; UK National Ecosystem Assessment. (2011). The UK National Ecosystem Assessment: Technical Report. UNEP-WCMC, Cambridge.

[20] Naeem et al.(2012). The functions of biological diversity in an age of extinction. *Science*, *336*(6087), 1401-1406

[21] Lawton et al. (2010). Making Space for Nature: a Review of England's Wildlife Sites and Ecological Network. *Report to DEFRA*.

[22] Gascon et al. (2015). The Importance and Benefits of Species. *Current Biology*, *25*(10), R431-R438; Winfree et al. (2015). Abundance of common species, not species richness, drives delivery of a real-world ecosystem service. *Ecology letters*; Jain et al. (2014). The importance of rare species: a trait-based assessment of rare species contributions to functional diversity and possible ecosystem function in tall-grass prairies. *Ecology and evolution*, *4*(1), 104-112.

[23] Mace et al. (2012). Biodiversity and ecosystem services: a multilayered relationship. *Trends in ecology & evolution*, *27*(1), 19-26; UK National Ecosystem Assessment. (2011). The UK National Ecosystem Assessment: Technical Report. UNEP-WCMC, Cambridge.

could impair ecosystem functioning and hence ecosystem service provision.[24] As surmised by the Lawton Review (2010), *"...there is good evidence that increased rates of some ecosystem processes are associated with increased numbers of species and as conditions change, different species may fulfil different roles...in an unpredictable world of changing climate there may be even greater need for this insurance or resilience effect through conserving species that do not immediately appear to be useful."*[25]

However, despite the large and growing body of evidence demonstrating the importance of biodiversity in underpinning the sustainable provision of ecosystem services and the potentially serious implications of further biodiversity loss for human-wellbeing, many uncertainties remain and our understanding of the quantitative linkages between different components of biodiversity and ecosystem services remains rather poor.[26] As stated by Diaz et al. (2006), *"Based on the available evidence, we cannot define a level of biodiversity loss that is safe, and we still do not have satisfactory models to account for ecological surprises."*[27] Current understanding of these relationships has been described as 'patchy', 'limited' and 'incomplete', due to a combination of the lack of data and the intrinsic complexity of the relationships involved.[28] As stated by Mace et al. (2012), *"...is biodiversity science well placed to address the challenges posed by an ecosystems approach? In broad terms, the answer is 'no'."*[29]

This uncertainty is particularly acute when it comes to the interdependencies between multiple ecosystem services and biodiversity over time.[30] According to the TEEB study (The Economics of Ecosystems and Biodiversity), *"we can state with high certainty that maintaining functioning ecosystems capable of delivering multiple services requires a general approach to sustaining biodiversity"*. However, *"it is not yet possible to account accurately for the role of biodiversity, nor the probable impact of its decline, on ecosystem service delivery in general*."[31] A recent review of the gaps in knowledge and future research needs for incorporating the 'ecosystem services' approach into EU biodiversity policy similarly concluded that much remains to be understood in terms of the ecological underpinnings of ecosystem service provision, in particular how changes in biodiversity influence ecosystem service provision over time.[32] This uncertainty is particularly concerning given the potential for abrupt and persistent/irreversible non-linear changes (and associated societal cost

[24] Science for Environment Policy. (2015). *Ecosystem Services and the Environment.* In-depth Report 11 produced for the European Commission, DG Environment by the Science Communication Unit, UWE, Bristol. Gascon et al. (2015). The Importance and Benefits of Species. *Current Biology*, *25*(10), R431-R438; Mouillot et al. (2013). Rare species support vulnerable functions in high-diversity ecosystems. *PLOS Biol. 11,* e1001569.

[25] Lawton et al. (2010). Making Space for Nature: a Review of England's Wildlife Sites and Ecological Network. *Report to DEFRA*.

[26] Balvanera et al. (2014). Linking biodiversity and ecosystem services: current uncertainties and the necessary next steps. *BioScience*, *64*(1), 49-57; Cardinale et al. (2012). Biodiversity loss and its impact on humanity. *Nature*, *486*(7401), 59-67. Carpenter et al. (2009). Science for managing ecosystem services: Beyond the Millennium Ecosystem Assessment. *Proceedings of the National Academy of Sciences*, *106*(5), 1305-1312; Hooper et al. (2012). A global synthesis reveals biodiversity loss as a major driver of ecosystem change. *Nature*, *486*(7401), 105-108; Kremen, C. (2005). Managing ecosystem services: what do we need to know about their ecology?. *Ecology letters*, *8*(5), 468-479; Srivastava, D. S., & Vellend, M. (2005). Biodiversity-ecosystem function research: is it relevant to conservation?. *Annual Review of Ecology, Evolution, and Systematics*, 267-294.

[27] Díaz et al. (2006). Biodiversity loss threatens human well-being. *PLoS biology*, *4*(8), 1300-1305.

[28] Balvanera et al. (2014). Linking biodiversity and ecosystem services: current uncertainties and the necessary next steps. *BioScience*, *64*(1), 49-57

Cardinale et al. (2012). Biodiversity loss and its impact on humanity. *Nature*, *486*(7401), 59-67; TEEB. (2010). The Economics of Ecosystems and Biodiversity Ecological and Economic Foundations. Edited by Pushpam Kumar. Earthscan, London and Washington.

[29] Mace et al. (2012). Biodiversity and ecosystem services: a multilayered relationship. *Trends in ecology & evolution*, *27*(1), 19-26; UK

[30] Science for Environment Policy (2015) *Ecosystem Services and the Environment.* In-depth Report 11 produced for the European Commission, DG Environment by the Science Communication Unit, UWE, Bristol.

[31] Muradian, R., & Rival, L. (2012). Between markets and hierarchies: the challenge of governing ecosystem services. *Ecosystem Services*, *1*(1), 93-100; TEEB. (2010). The Economics of Ecosystems and Biodiversity Ecological and Economic Foundations. Edited by Pushpam Kumar. Earthscan, London and Washington.

[32] Anton et al. (2010). Research needs for incorporating the ecosystem service approach into EU biodiversity conservation policy. *Biodiversity and Conservation*, *19*(10), 2979-2994.

increases) occurring as a result of critical thresholds being passed.[33] Predicting where such thresholds lie and the likely consequences of crossing them remain difficult.[34] Nevertheless, probable consequences include unexpectedly severe and difficult/impossible to reverse losses of ecosystem service benefits.[35]

In terms of species conservation, it is extremely challenging to assess the role that most individual species play in relation to ecosystem service provision and ecosystem stability.[36] As a result, the consequences of losing particular species are highly uncertain and are likely to remain so for the foreseeable future, such that making informed decisions regarding their conservation based solely on ecosystem service considerations is highly problematic. Of course, some species are known to play irreplaceable roles in ecosystems as 'keystone species', such that their loss would have a serious impact on ecosystem processes, but many of these relationships are poorly understood.[37] Similarly, some species are known to support highly distinct combinations of functional traits, such that their loss would be significant in terms of the long-term maintenance of ecosystem functioning.[38] Some of the most difficult species' benefits to assess are those that accrue unexpectedly or are wholly unanticipated. In some cases, we may only fully understand the benefits provided by a particular species when it is too late.[39]

Even in the UK, which has perhaps the most comprehensive data on biodiversity status and trends of any country in the world, the UK National Ecosystem Assessment (UKNEA, 2011) highlighted that that there is a significant lack of evidence linking biodiversity, ecosystem services, and human well-being. Although the available evidence is sufficient to demonstrate that biodiversity plays an important role in the sustainable provision of a range of ecosystem services, *"...it is often not good enough to allow us to distinguish services that are sensitive to even small levels of biodiversity loss from those that are more resilient to biodiversity loss."* Moreover, these knowledge gaps are particularly apparent with regard to knowledge about the dynamic response of ecosystems to present and future change and the implications of this for the integrated delivery of ecosystem services at different scales.[40]

The scientific uncertainty regarding these complex relationships is further exacerbated by the challenges associated with valuing biodiversity as part of an ecosystem service assessment, thus fundamentally limiting the extent to which it can be fully considered in decision-making.[41] Of course, when it comes to justifying action to conserve biodiversity based on the 'value' of nature, it is important to be clear what we are talking about; the term value can be interpreted in a variety of ways, both in terms of instrumental usefulness or worth and in terms of ideals, beliefs, principles or standards. The concept of ecosystem services is concerned with the instrumental value of nature i.e. the value of nature to humans, and assessing this in monetary terms is increasingly seen as an important component of the 'ecosystem services' approach. Estimates of the monetary value of ecosystem services are thus increasingly being used as a key input into decision-making processes

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[33] Chapin III et al. (2000). Consequences of changing biodiversity. *Nature*, *405*(6783), 234-242.

[34] Haines-Young, R., & Potschin, M. (2010). The links between biodiversity, ecosystem services and human well-being. *Ecosystem Ecology: a new synthesis*, 110-139. Cambridge University Press.

[35] Helm, D. (2014). Taking natural capital seriously. *Oxford Review of Economic Policy, 30, 109–125;* Kremen, C. (2005). Managing ecosystem services: what do we need to know about their ecology?. *Ecology letters*, *8*(5), 468-479; Mace et al. (2015). Towards a risk register for natural capital. *Journal of Applied Ecology*, *52*(3), 641-653.

[36] Gascon et al. (2015). The Importance and Benefits of Species. *Current Biology*, *25*(10), R431-R438.

[37] Şekercioğlu et al. (2004). Ecosystem consequences of bird declines. *Proceedings of the National Academy of Sciences*, *101*(52), 18042-18047; Gascon et al. (2015). The Importance and Benefits of Species. *Current Biology*, *25*(10), R431-R438.

[38] Mouillot et al. (2013). Rare species support vulnerable functions in high-diversity ecosystems. *PLOS Biol. 11,* e1001569.

[39] TEEB. (2010). The Economics of Ecosystems and Biodiversity Ecological and Economic Foundations. Edited by Pushpam Kumar. Earthscan, London and Washington.

[40] Norris et al. (2011). 4. Biodiversity in the Context of Ecosystem Services. In: The UK National Ecosystem Assessment Technical Report. UK National Ecosystem Assessment, UNEP-WCMC, Cambridge.

[41] Science for Environment Policy. (2015). *Ecosystem Services and the Environment.* In-depth Report 11 produced for the European Commission, DG Environment by the Science Communication Unit, UWE, Bristol.

in relation to the natural environment. However, as stated in a recent peer-reviewed paper on the topic involving members of the UK Natural Capital Committee *"Valuing ecosystems and biodiversity...is a complex endeavour and often at the frontier of valuation knowledge"*. As such, we need to be *"mindful of the complexities and uncertainties involved."*[42] Ecosystems are highly complex and interconnected such that it will rarely, if ever, be possible to express their 'total' value in terms of their contribution to human health and well-being in a single metric; accounting for the full range of services and the synergies and trade-offs between them is extremely challenging if not impossible.[43]

When it comes to biodiversity in particular, the consensus view is that it is extremely challenging to assess its value in monetary terms *"to any acceptable degree of validity."*[44] In particular, existing valuation techniques are unable to accurately assess the 'non-use' values associated with biodiversity (such as the values people hold regarding the continued existence of species in the wild that they may never see)[45] due to a combination of methodological shortcomings, limited data, and the high levels of uncertainty and complexity involved.[46] As stated by Helm and Hepburn (2012), *"Biodiversity is complex, difficult to define, difficult to measure, and often involves international and intergenerational considerations. Biodiversity loss presents significant economic challenges… [it is] a particularly intractable economic problem."*[47] A key issue from a valuation perspective relates to the role of biodiversity in underpinning ecosystem stability and the fact that valuation techniques based on 'marginal analysis' cease to be applicable in those situations where biodiversity loss is likely to be associated with non-linear changes in the flow of ecosystem services, many of which may be persistent or irreversible.[48]

Beyond these issues, there are also more fundamental challenges to the ecosystem services approach relating to importance of acknowledging the strong moral case for conservation, although whether this should be based on the concept of nature's 'intrinsic value' or a broader conception of its 'instrumental value' than is typically used is open to debate.[49] What is extremely clear, however,

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[42] Atkinson et al. (2012). Recent advances in the valuation of ecosystem services and biodiversity. *Oxford Review of Economic Policy*, *28*(1), 22-47.

[43] Primmer et al. (2015). Governance of Ecosystem Services: A framework for empirical analysis. *Ecosystem Services* (in press); Primmer, E., & Furman, E. (2012). Operationalising ecosystem service approaches for governance: do measuring, mapping and valuing integrate sector-specific knowledge systems?. *Ecosystem Services*, *1*(1), 85-92.

[44] Bateman et al. (2011). Economic analysis for ecosystem service assessments. *Environmental and Resource Economics*, *48*(2), 177-218.

[45] An example of this is the fact that in only a single week 10,000 people signed a petition to save the Horrid groundweaver spider *Nothophantes horridus* from a proposed housing development in Plymouth, despite that fact that most will never see it and would probably not recognise it even if they did. For further information on 'non use' values, see McCarthy, D. & Morling, P. (2014). *A Guidance Manual for Assessing Ecosystem Services at Natura 2000 Sites*. Produced as part of the Natura People project, part financed by the European Regional Development Fund (ERDF) through the INTERREG IV A 2 Mers Seas Zeeën Crossborder Programme 2007-2013. Royal Society for the Protection of Birds: Sandy, Bedfordshire.

[46] Atkinson et al. (2012). Recent advances in the valuation of ecosystem services and biodiversity. *Oxford Review of Economic Policy*, *28*(1), 22-47; Chan et al. (2012). Where are cultural and social in ecosystem services? A framework for constructive engagement. *BioScience* 62(8): 744-756; Daniel et al. (2012). Contributions of cultural services to the ecosystem services agenda. *Proceedings of the National Academy of Sciences*, *109*(23), 8812-8819; Helm, D., & Hepburn, C. (2012). The economic analysis of biodiversity: an assessment. *Oxford Review of Economic Policy*, *28*(1), 1-21; Plieninger et al. (2013). Assessing, mapping, and quantifying cultural ecosystem services at community level. *Land Use Policy*, *33*, 118-129; Science for Environment Policy. (2015). *Ecosystem Services and Biodiversity .* In-depth Report 11 produced for the European Commission, DG Environment by the Science Communication Unit, UWE, Bristol.

[47] Helm, D., & Hepburn, C. (2012). The economic analysis of biodiversity: an assessment. *Oxford Review of Economic Policy*, *28*(1), 1-21;

[48] Atkinson et al. (2012). Recent advances in the valuation of ecosystem services and biodiversity. *Oxford Review of Economic Policy, 28*(1), 22-47; Farley, J. (2012). Ecosystem services: The economics debate. *Ecosystem Services, 1*(1), 40-49; Hails, R. S., & Ormerod, S. J. (2013). Editorial: ecological science for ecosystem services and the stewardship of natural capital. *Journal of Applied Ecology, 50*(4), 807-810.

[49] As highlighted by Jax et al. (2013). Ecosystem services and ethics. *Ecological Economics*, *93*, 260-268: *"Whether values are considered as existing independently from human valuation or are the result of human attribution, is still an open controversy in environmental ethics. Nevertheless, to say that humans attribute value to non-human nature does*

is that an overly narrow conception of the latter fails to adequately capture the deeply held values that people ascribe to nature, particularly when it comes to the belief that nature should be conserved for its own sake.[50] Both the Convention on Biological Diversity (CBD) and the EU Biodiversity Strategy to 2020 explicitly recognise the importance of conserving biodiversity both for its 'intrinsic value' and for its role in underpinning human well-being.[51] There is a growing body of evidence demonstrating that people care about conserving biodiversity not only because it provides us with a range of material goods and services, but also because it is the right thing to do. Repeated surveys have demonstrated that nearly all EU citizens (over 90%) think it is important to halt biodiversity loss, and that the majority see this first and foremost as a moral obligation.[52] A key concern is that accounting for these values or beliefs within the ecosystem services framework is extremely challenging, such that an 'ecosystem services' approach on its own will not necessarily ensure that societal preferences for biodiversity conservation are met.[53]

The uncertainty and complexity regarding the quantitative links between biodiversity and ecosystem services (in particular when it comes to trade-offs and the implications of biodiversity loss in terms of ecosystem resilience/thresholds), alongside the challenges of assessing these relationships in monetary terms and incorporating these values into decision-making, has practical implications when it comes to designing and implementing appropriate policy responses to conserve biodiversity. In particular, it makes it clear that an approach focused solely on optimising the provision of ecosystem services will not necessarily protect biodiversity or ensure that the future ability of ecosystems to provide multiple services is maintained.[54]

In fact, the straightforward implication of over two decades of research into the relationships between biodiversity, ecosystem functions, and ecosystem services is essentially a re-statement of the precautionary principle.[55] For example, Daily (2000) states that *"...the level of uncertainty in our understanding of ecological processes, together with the prevalence of non-linearities and irreversibilities, calls for invoking a precautionary principle....it would be prudent to avoid courses of action that involve possibly dramatic and irreversible consequences and, instead, to wait for better information before putting ecosystem capital at great risk."* [56] Similarly, Gascon et al. (2015) state that "...*the precautionary principle with regard to the continued existence of species should guide development and conservation decisions at all scales*".[57]

Similar recommendations emerge from the economics literature on this topic.[58] For example, the economic analysis conducted as part of the UKNEA (2011) recommended the adoption of a risk averse strategy whereby precautionary standards for biodiversity conservation are set (e.g.

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not necessarily imply that they merely value it instrumentally." See also Justus et al. (2009). Buying into conservation: intrinsic versus instrumental value. *Trends in Ecology & Evolution*, *24*(4), 187-191.

[50] Reyers et al. (2012). Finding common ground for biodiversity and ecosystem services. *BioScience*, *62*(5), 503-507.

[51] European Commission. (2011). *Our life insurance, our natural capital: an EU biodiversity strategy to 2020*. COM (2011) 244 final.

[52] http://ec.europa.eu/public_opinion/flash/fl_379_en.pdf

[53] Lyons et al. (2005). Rare species and ecosystem functioning. *Conservation Biology*, *19*(4), 1019-1024; Mace et al. (2010). Biodiversity targets after 2010. *Current Opinion in Environmental Sustainability*, *2*(1), 3-8; Mace et al. (2012). Biodiversity and ecosystem services: a multilayered relationship. *Trends in ecology & evolution*, *27*(1), 19-26; Ridder, B. (2008). Questioning the ecosystem services argument for biodiversity conservation. *Biodiversity and Conservation*, *17*(4), 781-790.

[54] Adams, W. M. (2014). The value of valuing nature. *Science*, *346*(6209), 549-551; Maes et al. (2014) *Mapping and Assessment of Ecosystems and their Services. Indicators for ecosystem assessments under Action 5 of the EU Biodiversity Strategy to 2020.* Publications office of the European Union, Luxembourg.

[55] Naeem et al. (2012). The functions of biological diversity in an age of extinction. *Science*, *336*(6087), 1401-1406; Srivastava, D. S., & Vellend, M. (2005). Biodiversity-ecosystem function research: is it relevant to conservation?. *Annual Review of Ecology, Evolution, and Systematics*, 267-294.

[56] Daily, G. C. (2000). Management objectives for the protection of ecosystem services. *Environmental Science & Policy*, *3*(6), 333-339.

[57] Gascon et al. (2015). The Importance and Benefits of Species. *Current Biology*, *25*(10), R431-R438.

[58] TEEB. (2010). The Economics of Ecosystems and Biodiversity Ecological and Economic Foundations. Edited by Pushpam Kumar. Earthscan, London and Washington.

optimising ecosystem service provision subject to a set of minimum standards linked to the conservation of species and habitats), whilst Atkinson et al. (2012) in their article on 'Recent advances in the valuation of ecosystem services and biodiversity' state that "...*caution (given what might be lost) might be a sensible watchword".*[59] In other words, in the face of considerable uncertainty, a precautionary approach is recommended, such as the adoption of ecological 'safe minimum standards' that ensure the continued existence of species or precautionary limits beyond which biodiversity should not be allowed to decline.[60] Lawton et al. (2010) in the English context goes so far as to state that, in the face of such uncertainty *"...a precautionary approach is not optional, it is essential."*[61]

In practical terms, this requires policies (e.g. regulations and incentives) that encourage the management of ecosystems *"...to support biodiversity across a wide range of groups..."* including via the designation and management of protected areas (e.g. under the Nature Directives) as part of a suite of 'response options'; according to the UKNEA (2011) such an approach would be robust under a range of plausible future scenarios.[62] This line of thinking fits with current approaches to biodiversity conservation around the world, including Europe. For example, a key conclusion of the EU-funded RUBICODE project (Rationalising Biodiversity Conservation in Dynamic Ecosystems) was that conservation cannot simply be focussed on ecosystem services. Instead a precautionary approach should be followed whereby *"...ecosystems are maintained intact as far as possible"*.[63]

"Conserving the ecosystems and wildlife that we have today will...maximise our future options and improve our chances of achieving health and prosperity for ourselves and our children" – Sir John Lawton (2010).[64]

In summary, from both an ecological, economic, and ethical perspective, an 'ecosystem services' approach is poorly equipped for ensuring that the importance of biodiversity is not overlooked or undervalued in the absence of dedicated conservation policies, particularly when it comes to individual species and habitats. Of course, this is not to suggest that the 'ecosystem services' approach should not be used alongside the existing EU biodiversity policy framework. Greater efforts to understand the linkages between biodiversity and human wellbeing and to pursue management strategies that seek to deliver benefits for people and nature should be supported. However, what it does suggest is that it should be seen as a complement to, rather than a substitute for, existing biodiversity conservation policies. If we are to achieve the EU's biodiversity policy objectives and ensure the sustainable provision of ecosystem services, dedicated policies targeting the conservation of species and habitat will continue to be required for the foreseeable future. The current approach to the conservation of species and habitats in Europe, particularly via the Natura 2000 network is the right one, an "*intelligent approach founded on the precautionary principle."*[65] As

[59] Atkinson et al. (2012). Recent advances in the valuation of ecosystem services and biodiversity. *Oxford Review of Economic Policy*, *28*(1), 22-47

[60] Atkinson et al. (2012). Recent advances in the valuation of ecosystem services and biodiversity. *Oxford Review of Economic Policy*, *28*(1), 22-47; Bateman et al. (2011). Economic analysis for ecosystem service assessments. *Environmental and Resource Economics*, *48*(2), 177-218; Helm, D., & Hepburn, C. (2012). The economic analysis of biodiversity: an assessment. *Oxford Review of Economic Policy*, *28*(1), 1-21. Helm, D. (2014). Taking natural capital seriously. *Oxford Review of Economic Policy, 30, 109–125;* Natural Capital Committee. (2014). Towards a Framework for Defining and Measuring Changes in Natural Capital. Working Paper 1.Pearce et al. (2006) *Cost-benefit analysis and the environment: recent developments.* Organisation for Economic Co-operation and Development, Paris, France.

[61] Lawton et al. (2010). Making Space for Nature: a Review of England's Wildlife Sites and Ecological Network. *Report to DEFRA*.

[62] UK National Ecosystem Assessment. (2011). The UK National Ecosystem Assessment: Technical Report. UNEP-WCMC, Cambridge; UK National Ecosystem Assessment Follow-on. (2014). The UK National Ecosystem Assessment Follow-on: Synthesis of the Key Findings. UNEP-WCMC, LWEC, UK.

[63] Haslett et al. (2010). Changing conservation strategies in Europe: a framework integrating ecosystem services and dynamics. *Biodiversity and Conservation*, *19*(10), 2963-2977.

[64] Lawton et al. (2010). Making Space for Nature: a Review of England's Wildlife Sites and Ecological Network. *Report to DEFRA*

[65] Gascon et al. (2015). The Importance and Benefits of Species. *Current Biology*, *25*(10), R431-R438.

stated by a recent review conducted for the European Commission, we "...*neglect biodiversity protection at grave risk, even if we do not yet know of a 'purpose' for all of it. Policies to monitor and protect ecosystem services should not replace those designed to monitor and protect biodiversity."*[66]

In terms of EU policies more generally, there are a wide range of policies in addition to the Nature Directives that affect land-use/land management and thus biodiversity and the sustainable provision of ecosystem services. The fate of European biodiversity and the ecosystem services it underpins is thus closely intertwined with policy developments in these areas.[67] A key issue is that, outside of the Natura 2000 network, most ecosystems are managed in ways that seeks to maximise the short-term provision of individual services (e.g. agricultural outputs) to the detriment of biodiversity and many other services. EU sectoral policies such as the Common Agricultural Policy (CAP) have failed thus far to correct these serious market failures, despite considerable investment of public funds. Although the Nature Directives already contain specific provisions requiring Member States to take measures outside Natura 2000 sites to improve the ecological coherence of the network, achieving this will be challenging without reform of the key EU sectoral policies. There remains significant scope for improving the integration of biodiversity and ecosystem services into such policies. Analysis conducted as part of the UK NEA (2011) suggests that improved incorporation of ecosystem service values into land-use planning, in combination with policies that protect biodiversity (via the imposition of 'sustainability constraints' owing to the challenge of valuing biodiversity impacts in monetary terms), could both enhance societal well-being and deliver conservation benefits. However, achieving this in practice would require a substantial change in existing land-use policies, including fundamental reform of the CAP.[68] Unfortunately, the most recent reforms are unlikely to contribute to this, a particular concern given the state of biodiversity in habitats associated with agriculture and the important ecosystem services that such habitats could provide.[69]

Note: The issues discussed in this submission apply equally in relation to the marine environment.

[66] Science for Environment Policy. (2015). *Ecosystem Services and the Environment.* In-depth Report 11 produced for the European Commission, DG Environment by the Science Communication Unit, UWE, Bristol.

[67] EEA. (2015). SOER 2015 — The European environment — state and outlook 2015. http://www.eea.europa.eu/soer-2015/synthesis/report/3-naturalcapital

[68] Bateman et al. (2013). Bringing ecosystem services into economic decision-making: land use in the United Kingdom. *Science*, *341*(6141), 45-50.

[69] Pe'er et al. (2014). EU agricultural reform fails on biodiversity. *Science*, *344*(6188), 1090-1092.