System of Environmental Economic Accounting

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*Background paper*

*Session 3b: Ecosystem condition*

# Issues note on Biodiversity and ecosystem condition accounts

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**Issues Note for discussion at the SEEA EEA Technical Working Group - June 2019**

**Working Group 2: Ecosystem condition**

**Topic: Biodiversity and ecosystem condition accounts**

The question of how biodiversity relates to ecosystem condition accounts arose during both the drafting and review phases of the papers on ecosystem condition. This issue note draws together the points made about biodiversity across the papers, summarises the reviewers' comments, and provides some initial recommendations. We note that there is a separate discussion paper that specifically addresses how biodiversity can be incorporated into SEEA more broadly (Obst et al. 2019). The focus of this issue note is specifically on biodiversity as it relates to the ecosystem condition account.

## *1. Current status, background and issues raised in the Discussion Papers*

In this section we set out selected, edited excerpts of the current text related to biodiversity from Discussion Papers 2.1, 2.2 and 2.3. Discussion Paper 2.1 deals with the purpose and role of ecosystem condition accounts, Discussion Paper 2.2 reviews existing ecosystem condition accounts, and Discussion Paper 2.3 proposes a typology of condition variables for ecosystem accounting.

**The role of biodiversity in ecosystem condition accounts (see full text in Discussion Paper 2.1, Section 5.2)**

Biodiversity is defined in the SEEA EEA according to the Convention on Biological Diversity article 2 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 and of ecosystems*" (SEEA EEA 2.7). Biodiversity is conceptualized as a hierarchy at the levels of genetic, species and ecosystem diversity. The term biodiversity is used in this broad inclusive form in the discussion papers about ecosystem condition accounting. Where only species are considered this is referred to as species diversity.

In the SEEA EEA, the definition of 'ecosystems' uses that from the Convention on Biological Diversity article 2, where ecosystems are a "*dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit*" (SEEA EEA 1.52). The spatial accounting units should be based on ecosystem types. Ecosystem condition is influenced by the ecological processes involving interactions of the biota and the physical environment. Ecosystem accounting should be conducted at the level of the ecosystem rather than at the level of the individual species, although species-based indicators may represent characteristic elements on an ecosystem. Characteristics of ecosystems related to ecosystem processes and landscape pattern can incorporate both biotic and abiotic components.

The World Conservation Monitoring Centre has developed guidelines for the description of species accounts within the SEEA framework[1]. The role of species within ecosystem accounts is described as "*species and other aspects of biodiversity are key features of ecosystem condition*" and "*ecosystem condition characteristics include species assemblages*". Species selection and development of

[1] King S, Brown C, Harfoot M, Wilson L 2016. Exploring approaches for constructing species accounts in the context of the SEEA-EEA. UNEP-World Conservation Monitoring Centre, Cambridge, UK

accounts can address different purposes for ecosystem condition or ecosystem services or conservation concern.

Species diversity is only one component of biodiversity that contribute to quantifying characteristics of ecosystem condition that occur at many scales. Biodiversity is not necessarily positively or linearly related to ecosystem condition for other purposes. For example, some of the most species-rich ecosystems, like shrublands in Mediterranean climates such as south-west Western Australia and south-western South Africa, have a low capacity to provide a range of ecosystem services due to infertile soils and low water availability, but high biodiversity importance.

There are no universally acknowledged metrics for biodiversity. Nevertheless, various metrics describing components of biodiversity can generally be positively associated with ecosystem integrity and ecosystem function, although may not be linear. Relationships depend very much on the components of biodiversity investigated (for example, species richness, abundance, functional richness, distribution). There are cases where biodiversity (in terms of species richness) is naturally low but condition scores may be high or good.

The ecosystem characteristics related to biodiversity that are included in condition accounts can address values relating to any of the perspectives described in Paper 2.1, including ecocentric, anthropocentric, intrinsic and instrumental values (from a conservation perspective particularly in ecocentric and intrinsic value frameworks); quantification can be in the form of variables, indicators or aggregate indices. By contrast, characteristics related to the capacity to supply ecosystem services must lie within the instrumental value framing.

The review of condition accounts in Discussion Paper 2.2 found that various biodiversity indicators were ubiquitous. Notably, the review found that the term "biodiversity indicators" is often used to mean species-based indicators, but in principle "biodiversity indicators" could relate to genes, species or ecosystems. A recommendation is thus to avoid using the term "biodiversity indicators" when referring specifically to species-based indicators.

Discussion Paper 2.3 proposes a typology of indicators, drawing on an extensive literature and long-standing ecological tradition (composition, structure and function, cf. Noss, 1990[2], and the Essential Biodiversity Variables, Pereira et al. 2013[3]). Species-based indicators comprise a broad range of 'typical' biodiversity indicators, describing the composition of ecological communities from a biodiversity perspective (Discussion paper 2.3). This includes the indicators based on the presence/abundance of a species or species group, or the diversity of specific species groups at a given location and time.

### *2. What are the issues?*

This section collates comments from the review process relating to biodiversity in measuring ecosystem condition, grouped under broad headings.

**On definition of terms (what is biodiversity):**
*Jeanne Nel Netherlands/Wageningen Environmental Research South Africa/Nelson Mandela University:* I like the solid stance taken on (RE-)defining biodiversity. Congratulations on distinguishing species-based indicators from the full basket of biodiversity and not conflating these. I

[2] Noss, R. F. (1990). Indicators for Monitoring Biodiversity: A Hierarchical Approach. *Conservation Biology* **4**:355-364.
[3] Pereira, H. M., et al. (2013) Essential Biodiversity Variables. *Science* **339**:277-278.

do not know when the biodiversity community started conflating these, but it is well appreciated that this conflation is removed in the guidelines here and proposals go well beyond just taxonomic units and species.

*UNSD:* On the framework conformity paragraph (DP2.3 page 6). We were not sure if this exclusion is necessary. For example, if we're talking about biodiversity the species count may be part of the condition account, as well as of a separate biodiversity account (if defined later). Could you please clarify the 'double counting' mentioned here, as it may not be exactly the same as what statisticians would think of as double counting. On measures of biodiversity. We thought that the links are not attributed well enough, but we also recognize that the area of biodiversity will need a special consideration.

*Erik Framstad (Norway/NINA):* I think good coverage of biodiversity is critical and that this concept needs to be structured according to the conceptual model of Noss (1990), with good examples of relevant indicators allocated to the classes of table 2 (in DP2.3) (see further comments under Q6).

**Indicators of biodiversity and their position within the values framework**

*Petteri Vihervaara & Minna Pekkonen Finland/Finnish Environment Institute (SYKE):* Page 27 says: "Species diversity is only one component of biodiversity that contribute to quantifying characteristics of ecosystem condition that occur at many scales. Biodiversity is not necessarily positively or linearly related to ecosystem condition for other purposes." This highlights the ambivalence throughout DP2.1 whether condition is measuring ecosystem itself (intrinsic, and closely related to biodiversity) or ecosystem for ecosystem services. I think that accounting of ecosystem condition should be measuring state of ecosystem itself without interpretation for human benefits. Latter steps of EEA focus on ecosystem services. References to numerous GEO BON related papers describing Essential Biodiversity Variables and harmonised way to monitor biodiversity are missing from DP2.1, but in DP2.3 they are well included. The linkage from EBVs (e.g. ecosystem extent, structure and condition) to ecosystem accounting should be carefully considered in the revised guidelines. Priority issues: interpretations of biodiversity, species and ecosystem accounts

*Yann Kervinio, FRANCE:* On the typology (Q6): This typology is little operational and risky. At present, it still relies on the assumption that it will be possible, at some point, to establish systematic linkages between a set of conditions indicators and ecosystem service capacity. This is not the case now and it is likely that this will not change so soon.

Instead, France proposed that ecosystem condition could be defined more practically along three classes that cover the mains objectives underlying integrated ecosystem management (resulting from different and competing values):

1. the objective of conserving remarkable biodiversity,
2. the objectives of maintaining the capacity of ecosystems to sustainably provide goods and services,
3. the objective of maintaining ecosystem overall functioning.

Taking this as the basis of the analysis about what is to be monitored along the many potential biophysical dimensions of ecosystems would greatly improve the policy relevance of the accounts.

On biodiversity :

Biodiversity per se can be incorporated as a determinant for each of the three types of conditions indicators mentioned:

- biodiversity in a heritage to preserve
- biodiversity underpins ecosystem services such as these related to genetic resources
- biodiversity is a determinant of ecosystem resilience

A study about how to incorporate biodiversity would have to review and specify first what biodiversity indicators exactly underpin each of these set of objectives and then discuss the redundancy between these indicators.

*Per Arild Garnåsjordet, Kristine Grimsrud and Iulie Aslaksen, Statistics Norway*: Basically, we think that biodiversity in one or another way will always be considered as one important aspect of ecosystem condition. In for example urban areas the amount of different green spaces is perhaps the most important issue, and can we get more quality measures about types of green, like bushes and trees, as well as the characteristics of agricultural areas, like allotments and small gardening areas for production of vegetables, berries and apples. We start out to have information about biodiversity, and may subsequently say something about potential for pollination.

**Species richness as an implicit measure of biodiversity:**
*Petteri Vihervaara & Minna Pekkonen Finland/Finnish Environment Institute (SYKE):* Role of biodiversity: preference to measure ecosystems rather than species is mentioned – how about marine ecosystems where habitats are often consisted of assemblages of a few species?

*Prof. Tom Oliver University of Reading, United Kingdom*: Biodiversity measurements. Some consideration is needed here about the normativity of measures of biodiversity. More species is not always a 'good' thing. For example, lowland heathland habitats might have fewer but more priority/endemic species. A change in the habitat with more generalist and invasive species might increase species richness and other diversity metrics, but might degrade the value of this habitat. Therefore, species condition metrics might want to assess a smaller number of selected species that are species indicators of the habitat in its desired reference state (i.e. similar to plant species that used as ancient woodland indicators).

### *3. Recommendations*

The main recommendations emerging from the discussion on biodiversity within condition accounts broadly agrees with those from the note on biodiversity within SEEA more broadly. That is, SEEA does not create a single "*biodiversity account: some aspects (e.g. the presence/abundance of threatened ecosystem types) are covered by the extent accounts, most others (e.g. the abundance and diversity of local species populations) are covered by the condition accounts, whereas some (e.g. the genetic diversity within the species) may not be covered at all*." (Obst, 2019)

**Clarity in terminology, definitions and their use:**
An important issue is the ambiguity surrounding important terms relating to biodiversity; this includes the term biodiversity itself, often interpreted as species diversity or richness, and habitat (sometimes meaning natural ecosystems, sometimes habitat for a specific species). We recommend clear definition of terms, and in particular breaking down biodiversity into its components to reduce ambiguity. For example, we recommend avoiding using the term "biodiversity indicators" when referring specifically to species-based indicators. The term "biodiversity indicators" is often used to mean species-based indicators, but in principle "biodiversity indicators" could relate to genes, species or ecosystems, and should be referred to as such specifically to avoid ambiguity (EC discussion paper 2.2).

**Biodiversity in condition variables and indicators:**
Biodiversity is included in the proposed typology of ecosystem condition metrics presented in Discussion Paper 2.3, in terms of various components of biodiversity within different classes that

describe compositional, structural and functional characteristics of ecosystems, and include spatial scales from species to landscapes. A wide range of metrics describing different components of biodiversity is potentially useful to quantify these characteristics, with selection based on the purpose within the values framework and the criteria for appropriate metrics. Where the metrics relate to species, these are referred to as species-based indicators that quantify species diversity. Many other components of biodiversity are also relevant and contribute to quantifying characteristics of ecosystem condition, and should not be constrained to taxonomic units (Paper 2.1, recommendations).

While species-based indicators can play an important role as metrics of ecosystem condition, they are not *essential* for measuring condition, and in many cases data for species-based indicators may not be available. Discussion Paper 2.2 (Table 1) outlines a set of criteria for selecting indicators, which provide guidance for identifying when species-based indicators (and other biodiversity indicators) are appropriate; these include relevance, spatial and temporal consistency, reliability and feasibility. Importantly the relationship between the variable and ecosystem condition need to be well-understood as an informative indicator of condition.

**Biodiversity as more than species richness:**
Importantly, measures of species diversity should not focus solely on species richness or taxonomic diversity. Rather, condition measures should also consider functional diversity, presence or abundance of certain keystone or indicator species, where appropriate. Measures of species richness or diversity should also be done in terms of reference levels, rather than absolute values; for example, ecosystems with naturally low species richness should not be considered in worse condition than those with naturally high species richness.

**Consideration of scale:**
There are a wide range of potential condition metrics that consider aspects of biodiversity, some of which only make sense when aggregated to appropriately large spatial scales. Although this problem is not unique to the biodiversity and condition accounts, it is more severe than for many of the other accounts. For example, a measure of average soil moisture or soil carbon in the water or carbon accounts, or a dominant unit of a LULC type in the extent accounts, makes sense at multiple spatial scales; for example, it is reasonable to describe at 25 by 25m resolution, 1 by 1km resolution, or more aggregate scales. However, metrics such as ecosystem connectivity and fragmentation, or measures of diversity such as Shannon's index, are not meaningful at small scales – they only make sense when spatially aggregated above a threshold size. Presence and absence, abundance and species richness also are often only meaningful over a particular range of spatially aggregate scales. Indicators of population or ecosystem viability, such as risk of species extinction or ecosystem collapse (at global or regional scales), can account for the larger context of biodiversity conservation values, e.g. Red List Index, rather than treating areas in isolation.