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# Options for Incorporating biodiversity in the SEEA

*Discussion note*

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# SEEA EEA REVISION

# OPTIONS FOR INCORPORATING BIODIVERSITY IN THE SEEA

**Discussion note**

## EXECUTIVE SUMMARY

This note discusses the use of the term and concept of "biodiversity" in the System of Environmental-Economic Accounting (SEEA), including both the SEEA Central Framework and the SEEA Expertimental Ecosystem Accounting (SEEA EEA). The paper starts from the definition of biodiversity provided in the Convention on Biological Diversity (CBD) as spanning genetic, species, and ecosystem levels of ecological organisation. The same definition has been the starting point for discussion in the SEEA EEA but the assessment in this paper is that, in general, the use of the term "biodiversity" in the SEEA EEA has been as a synonym for "local species populations" – that is, the abundance and diversity of species within individual ecosystems. The paper also recognises that the concept of biodiversity (although not the term) also figures in the SEEA Central Framework at ecosystem levels (implicitly within the land cover accounts) and at species levels (within the natural resource asset accounts eg timber, fisheries).

The SEEEA EEA offers a more comprehensive coverage, but it does not create a single "biodiversity account". Thus some aspects (e.g. the presence/abundance of ecosystem types) are covered by the ecosystem extent accounts, many others (e.g. the abundance and diversity of local species populations) are incorporated in the condition accounts, but some aspects (e.g. the genetic diversity within the species, and capturing beta or gamma diversity) may not be covered at all.

The paper suggests a number of aspects for consideration in the current revision of the SEEA EEA and as part of the broader process of implementation and development of the SEEA. The intention of these proposals is to ensure that the SEEA accounts appropriate reflect all levels of diversity, that the definitions used are consistent in wording and interpretation with those of the CBD and other MEAs, and that descriptions and terminology are clear and unambiguous. The proposals are:

- to cease referring to local species populations as "biodiversity", and recognise that further research is necessary to understand the degree to which changes in local species populations predict changes in the condition of the ecosystem assets within which they are located
- to consider development of "species accounts" as a complement to the ecosystem accounts described in the SEEA EEA and structured to support understanding of the contribution of a given area (eg country) towards the global persistence of a given species
- over the longer term, to consider how (and indeed whether) to account for genetic diversity into the SEEA.

## BACKGROUND

The design and ongoing development of the UN System of Environmental-Economic Accounting Experimental Ecosystem Accounting (SEEA EEA) over the past 8 years has brought together experts from a wide range of disciplines across ecology, statistics, economics, accounting, geography, etc. A particular challenge in this space is to support the range of different concepts, terms and understandings such that mutually agreeable solutions can be found to the questions that ecosystem accounting poses.

A key area of interest is on the potential for the SEEA to support policy and decision making concerning the conservation and enhancement of biodiversity at levels other than ecosystems. While there is wide spread agreement that this is an important and appropriate area of investigation, there exist a variety of perspectives on the nature of the connection, and potential connection, between biodiversity and the SEEA framework broadly.

This note describes the current understanding of biodiversity within the SEEA. It is accepted however that this provides a particular, primarily statistics/accounting, perspective and the description will require broad discussion.

The note builds on past work, led by UNEP-WCMC (2015 & 2016) on linking the SEEA and biodiversity measurement, as well as on more recent discussions among those leading the work on the current revision process of the SEEA EEA and experts from the biodiversity community. Throughout, we follow the Convention on Biological Diversity definition of biodiversity as spanning genetic, species, and ecosystem levels of ecological organisation: i.e. “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”.

## SUMMARY OF THE SEEA FRAMEWORK

The SEEA is the internationally accepted statistical framework for the measurement of the relationship between the environment and the economy. It is broad ranging in scope, seeking to describe the relationship in terms of stocks and flows and in physical and monetary terms. Its design reflects the application of national accounting principles and concepts that are described in the System of National Accounts (SNA). The SNA is the internationally adopted standard for the measurement of the economy, providing definitions for economic measures such as gross domestic product (GDP). The SEEA essentially describes how environmental information can be blended with the standard national accounts to provide a richer set of information to support analysis and decision making.

The SEEA has two volumes - the SEEA Central Framework and the SEEA EEA. The SEEA Central Framework covers accounting for:

- physical flows (e.g. of water, energy, GHG emissions, waste)
- environmental transactions (e.g. environmental taxes, environmental subsidies, environmental expenditures)
- natural resources (e.g. minerals, energy resources, soil, timber, fish, water, land)

The SEEA EEA covers accounting for ecosystem assets, their condition and services (e.g. forests, wetlands, agricultural areas, marine areas and their services)

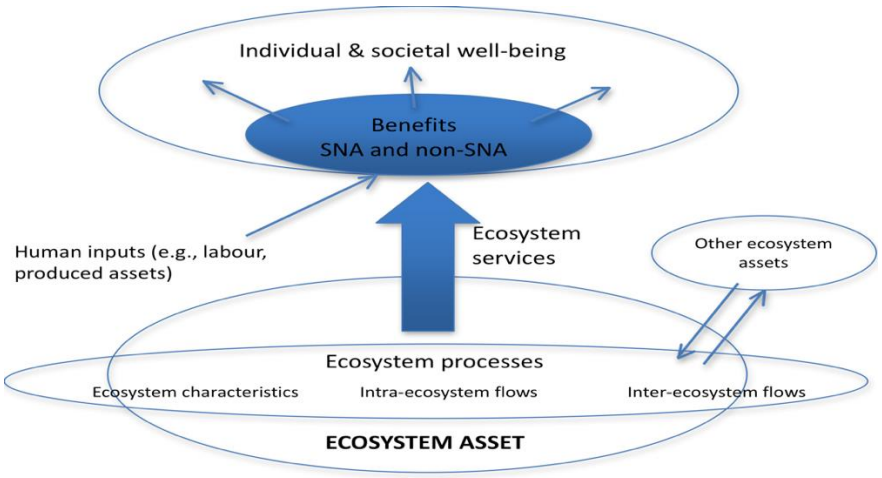
In the development of these volumes it is important to note that while the content of the SEEA Central Framework has been a topic of discussion among the statistical and national accounting communities

since the early 1990s, the development of ecosystem accounting has been much more recent commencing only around 2010. On the whole, the areas of traditional focus for the SEEA has not been on ecology but rather on natural resources and related flows. Consequently, the topic of biodiversity was not a feature in the development of the SEEA Central Framework.

The extension of the SEEA to consider ecosystems was driven from the need to determine way of incorporating changes in environmental condition and degradation into the accounts. It was from this perspective that the SEEA measurement community engaged more directly in the topic of biodiversity and the SEEA EEA has developed over the past 8-10 years alongside related areas of work including global initiatives such as TEEB and IPBES and has links to work in the CBD, IUCN and other agencies and programs. Given this entry point, the focus of this note is on better understanding the links between ecosystem accounting and biodiversity. However, this note also recognises that some parts of the SEEA Central Framework will also be relevant in considering the link between biodiversity and the SEEA. The note further recognises the potential for making the connection between SEEA and other levels of ecological organisation, namely species and genes. This would reflect a continuation of the development that has taken place in the accounting community.

The accounting framework of the SEEA EEA has been described at length in a number of places, most recently in the *Technical Recommendations in support of the implementation of the SEEA EEA (Technical Recommendations)*, completed in December 2017 and due for final publication in mid 2019. For the purposes of discussion here Figure 1 provides a depiction of the general model.

**Figure 1: General ecosystem accounting model (SEEA EEA Figure 2.2)**




Source: UN et al, 2014b

Five key features of the ecosystem accounting model are noted:

(i) The delineation of spatial areas. Ecosystem accounting is focused on accounting for ecosystem assets, each delineated by a spatial area. In the case of agriculture this could equate to a single farm or to a broader area, such as a rice farming area, with the understanding that each spatial area would consist of a similar vegetation type and cover. For the purposes of integrating ecosystem information about defined spatial areas with standard economic accounts and productivity measures, it is most useful to consider each ecosystem asset as a type of quasi-

producing unit, i.e. additional producing units to the standard economic units that comprise industries and households.

(ii) Measuring the condition of ecosystem assets. Each ecosystem asset (e.g. a contiguous set of rice fields) has numerous characteristics (climate, soil, vegetation, species diversity, etc.) and performs various ecosystem functions. The integrity and functioning of the asset is measured by its condition. It is the decline in overall condition, in biophysical terms, that underpins the measurement of ecosystem degradation. Asset accounts for ecosystem condition and ecosystem extent (i.e. the area of the ecosystem asset) are described in SEEA EEA. These accounts are compiled in biophysical terms only.

(iii) Measuring the flow of ecosystem services. Based on both the ecosystem asset's condition and the use made of the ecosystem asset (e.g. for rice production), a basket of ecosystem services will be supplied. The ecosystem services supplied are consumed by users, i.e. economic units including businesses, households and governments with these flows recorded in an ecosystem services supply and use account. The coverage of ecosystem services includes provisioning services (e.g. food, fibre, water), regulating services (e.g. air filtration, pollination, water flow regulation, carbon sequestration) and cultural services (e.g. recreation, spiritual connections, amenity services).

(iv) Relating ecosystem services to standard measures of economic activity. The supply of all ecosystem services is outside the production boundary of the SNA as they are considered natural processes (see SNA 2008, 6.24; Eigenraam and Obst, 2018). At the same time, many ecosystem services contribute to the production of goods and services that are included in the SNA production boundary, for example the contribution of water to rice production. To understand the impact on measures of GDP, it is necessary to recall that GDP is a measure of value added – i.e. output less intermediate inputs. Thus, where ecosystem services contribute to existing measures of output (as in the rich production case), the net effect on GDP of recording the supply of ecosystem services is zero, since the ecosystem services are considered both as additional outputs (of the ecosystem asset) and additional inputs to currently recorded production.[1]

The SEEA EEA also goes further in allowing for the inclusion of ecosystem services that are not inputs to currently recorded goods and services. For example, the carbon sequestration service of plants. It is this additional output, and associated value added, attributable to ecosystem assets, that directly increases measures of GDP.

(v) The use of exchange values. The ecosystem accounting model reflects relationships between stocks and flows that exist without regard for the unit of measurement. Thus, in concept, the accounting relationships can be reported in both physical and monetary units. Measurement in monetary terms requires the use of various valuation techniques since prices for ecosystem services and assets are not directly observed in markets as for standard economic products.

Economists have developed many valuation techniques to support analysis of environmental issues including the valuation of ecosystem services. For accounting purposes, some of these techniques are appropriate provided they estimate the *exchange value* or transaction price of an ecosystem service, i.e. the price at which a willing buyer and willing seller would complete a transaction of a single ecosystem service. Exchange values are required for accounting since they allow a balance between estimates of supply and demand to be maintained in monetary terms.

[1] Note that it is by recognizing ecosystem services as both outputs (of ecosystem assets) and inputs (to farming units) that double counting is avoided. The treatment is exactly analogous to the treatment of outputs and inputs through the standard supply chains recorded in standard input-output tables.

In concept, by estimating the monetary value of all ecosystem services supplied by an ecosystem asset, and then estimating the associated net present value of this basket of services, the value of the ecosystem asset itself is derived. The value of ecosystem degradation will be related to the change in the value of the ecosystem asset over an accounting period, noting that the value of the asset may change for reasons other than a decline in condition, e.g. through changes in land use; and that a loss in condition may not be due to human activity (e.g. storm damage) and hence would be excluded from ecosystem degradation for accounting purposes.[2]

Applying these five key elements of ecosystem accounting is reflected in four core types of accounts:

*Ecosystem extent accounts* summarise information on the composition and changes in composition of a given region (e.g. catchment, country) in terms of the area of different types of ecosystem assets. Work is ongoing at present to develop a classification of ecosystem types to support account compilation and international comparison, to date it has been common for accounting work to use land cover classes as a starting proxy.

*Ecosystem condition accounts* bring together information on the condition of ecosystem assets based on assessment of relevant characteristics. Work is ongoing to determine the most appropriate characteristics that should be incorporated in the measurement of condition for different ecosystem types for accounting purposes and also to determine the relevant reference condition.

*Ecosystem services flow accounts* focus on recording the supply of different ecosystem services by different ecosystem types and matching this with the users of those services, primarily economic units (businesses, households, governments). The supply-use pairing is central to the application of an accounting approach where flows of ecosystem services are analogous to transactions in traditional goods and services such as bread and transport. Using appropriate valuation techniques, as noted above, prices can be applied to flows of ecosystem services measured in quantitative terms to compile service flow accounts in monetary terms.

*Ecosystem monetary asset accounts* brings all of the information on size, condition and service flows together to provide estimates of the value and change in value of ecosystem assets over an accounting period. In doing this, standard accounting net present value (NPV) based approaches are applied where it is necessary to make assumptions about the future flow of services from ecosystems that consider the capacity of the ecosystem to supply the services which will in turn be a function of the ecosystem's extent and condition.

## BIODIVERSITY IN THE SEEA

The SEEA EEA uses as its starting point the CBD definition of ecosystems i.e. as "*a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit*". It is referenced in the SEEA EEA in paragraph 2.1. The SEEA EEA goes on to introduce key characteristics of ecosystems (para 2.4) ecosystem resilience and complex dynamics (para 2.6).

Biodiversity is introduced in para 2.7 again using the CBD definition i.e. that biodiversity is "*the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic*

[2] In national accounting degradation, like the depreciation of manufactured assets, is considered a cost against income from production and hence only the change in asset value that is attributable to the production activity should be deducted. Other changes in value are recorded in the accounts but not as a deduction from income.

*ecosystems and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems.*"

The SEEA EEA's brief introduction to ecosystems and biodiversity is summarised in the following way in para 2.11

> *"The interconnectedness of biodiversity and ecosystems is reflected in the fact that biodiversity is a fundamental characteristic of ecosystems, and that at the same time variability among ecosystems is a fundamental driver of biodiversity. There are therefore also important links among biodiversity, ecosystems and resilience which reflect the complex dynamics referred to above".*

From a non-ecological perspective this seems like a well-balanced reflection but it is clear, in hindsight, that there are some deeper and important aspects of the relationship between biodiversity and ecosystems that are not captured or understood. One aim in this note is to set a clear basis for further discussion of these fundamental aspects. A proposed revision of the paragraph would be:

> *"The interconnectedness of biodiversity including ecosystems is reflected in the fact that ecosystems and the variability among them are fundamental characteristics of biodiversity. There are therefore also important links among ecosystems and resilience which reflect the complex dynamics referred to above".*

Notwithstanding the upfront recognition of biodiversity encompassing genetic, species and ecosystem diversity, it is clear now that the discussion and perception of ecosystem accounting is that the use of the word biodiversity in the SEEA is most commonly used as referring to the diversity of species – indeed, this would be a reasonable interpretation of paragraph 2.11 above. Further, even simply the use of the term "ecosystem" accounting could give the impression that species and genes are not of particular focus, even though this was not the overall intention.

Since the drafting of SEEA EEA in 2012, ongoing discussions and in particular the work of UNEP-WCMC in this area, have started the process of clarifying collective understandings. The latest understandings are reflected in the Technical Recommendations of late 2017 and the discussion papers from the SEEA EEA revision process. Key points in terms of the current understanding of biodiversity in ecosystem accounting are:

- The attempt to more clearly and systematic refer to ecosystem diversity, species diversity and genetic diversity as appropriate rather than using the term biodiversity in all cases
- The continued recognition that changes in the abundance and diversity of local populations within an ecosystem are commonly an important characteristic in the assessment of ecosystem condition.
- Growing understanding that the link between changes in populations and ecosystem condition should not be considered hierarchically and there will likely be important issues of scale that need to be understood
- Moreover, there are no necessary connections between changes in the diversity of species within an ecosystem (local biodiversity) and changes in the contribution which that ecosystem makes to maintenance of the diversity of species worldwide (global diversity); the latter is manifest as extinction and extinction risk
- The understanding that accounting for ecosystem extent, and hence summarising information on the composition of ecosystem types, can provide data to support measurement of ecosystem diversity
- The ongoing description of local species population accounts (originally presented in SEEA EEA Chapter 4 and referred to as a biodiversity account) that provide a structure to record levels and

changes in the abundance of target species or other taxon. This data may be useful in supporting the derivation of indicators of local species population diversity, but not of global species diversity.

- The understanding that biodiversity is not an ecosystem service in all but very specific circumstances, rather biodiversity is a characteristic of stocks/assets that can be degraded or enhanced over time but is not directly used or consumed. (The exception would be in situations where people's motivation in engaging with nature is driven by its diversity rather than by specific species or ecosystems. For example, enjoyment of pandas, tigers or coral reefs is not considered to place a direct value on diversity. The potential for continued enjoyment of these species and ecosystems will be dependent on the diversity but this then reflects biodiversity's role as a critical underpinning an ecosystem's capacity to supply services into the future.)

In addition to ecosystem accounting, it is possible to see other parts of the SEEA as organising data in an accounting format relevant to the assessment of biodiversity even if this focus was not the intent in the account design. Potential connections can be seen in the following areas across the SEEA Central Framework.

- At an ecosystem level: data from land accounts in terms of land use or land cover may provide useful information on drivers of changes in ecosystem-level biodiversity (deforestation, urban expansion, etc) and could be organised to highlight, for example, levels and changes in protected areas within a country. (NB: These drivers will also influence biodiversity at other scales.)
- At a species level: data on individual species, or other taxon, may be the focus of natural resource accounting – e.g. accounts for timber resource or fish resources by species. The SEEA Central Framework has a short section on accounting for other biological resources (section 5.10) where it recognises the potential to apply the general natural resource accounting principles to record information on species, such as elephants and kangaroos, that may be of interest from a policy or management perspective.
- More generally:
    - data on environmental flows, especially residual flows including GHG emissions, air pollution, water pollution, will provide information to support understanding pressures on biodiversity
    - data on environmental protection and resource management expenditure may provide information to support understanding policy responses to reverse losses of biodiversity (it is noted here a long standing conversation between the SEEA project and the UNEP BIOFIN project to record expenditures)

## CLOSING THE GAPS IN UNDERSTANDING

Based on the description, there is clearly the potential for SEEA based data to support the development and management of biodiversity policy and analysis in many ways. In this context, one issue in narrowing the gaps in understanding is simply awareness. Notes such as these can be one part of the way forward.

However, there are three types of gaps to close. First, there remains considerable confusion over the use of terms and their alignment to different readers' understanding. Second, there are likely some fundamental conceptual challenges. Third, but not discussed here since it requires discussion with the biodiversity community, is the need to clarify the data and information requirements from a biodiversity

policy perspective and, from this, assess the potential for accounting based information to satisfy these requirements. An additional note discussing this gap would be a useful addition.

Concerning the first gap, a consistent thorn has been the use of the phrase "biodiversity accounting". Commonly the interpretation of this phrase is that there is one "account" for biodiversity which summarises all of the relevant information. However, a careful matching of the CBD definition to the SEEA EEA conceptual framework reveals that this would be the wrong expectation, as some aspects of biodiversity (e.g. the presence/abundance of threatened ecosystem types) are already covered by the extent accounts, others (the abundance and diversity of local species populations) are covered by the condition accounts, whereas some others (e.g. the genetic diversity within the species and measures of beta and gamma diversity) may not be covered at all. Furthermore, the SEEA must be considered as a system of accounts each playing its particular role. By way of simple analogy, for a business it is commonly understood that it would prepare a profit and loss statement and a balance sheet. These are two distinct accounts again (indeed strictly many accounts support these two reports). It should be accepted that to tell a comprehensive picture through the lens of stocks and flows, more than one account will be relevant.

It would therefore be useful to focus instead on "accounting for biodiversity"[3] and on working to describe the set of accounts that may be relevant in organising information and supporting decision making on biodiversity. Further, "accounting for biodiversity" can be interpreted as applying accounting principles to measure biodiversity. In fact, this is a good way to understand the work of UNEP-WCMC – i.e. how to use the SEEA's accounting principles to improve measurement. This may relate to having improved indicators of biodiversity but may also relate to having a stronger narrative about the relevance of biodiversity to economic and social activity.

Also concerning the first gap, for experts from the statistics/accounting community there are clearly misunderstandings of the biodiversity science and/or the lack of awareness of the different schools of thought. For example, the relationship between biodiversity and ecosystems can be portrayed in a number of ways sometimes with a focus on species, sometimes with a focus on functions and sometimes with a focus on services. At this point there would seem the need for further discussion and perhaps a supporting note or links to relevant material to tease out the relevant differences, recognising that it is not the task of the SEEA EEA to resolve differences of perspective among biodiversity experts.

On the second gap, it seems clear that the current description of ecosystem accounts in the SEEA EEA characterises the three types of biodiversity as nested – i.e. genes within species, and local species populations within ecosystems. This is evident in the choice of language, the idea that biodiversity is a characteristic of ecosystems and the description of species accounts as being supporting or "thematic" accounts.

Recent discussion has drawn out this issue more clearly and highlights the following points that provide some proposals for future discussion and research.

- That it may be useful to consider that ecosystem accounting provides a comprehensive accounting for the ecosystem level of biodiversity (which itself incorporates data on local species populations), in turn implying that there is currently no comprehensive accounting for other levels of biodiversity.
- That following this logic it would be beneficial to consider developing "species accounting" as a complementary system of accounts – namely extent/abundance; species condition, specific services related to species, monetary values for species.

[3] Recalling that in fact this was the title of the relevant section in the SEEA EEA.

- That in the longer term this same logic might be applied to the genetic level

This pathway forward would recognise that ecosystem accounting as currently expressed in the SEEA EEA is highly relevant with regard to supporting discussion of biodiversity at ecosystem levels but that it is not complete and that the accounting approach may be further applied to other aspects of biodiversity.As part of this consideration of species accounting, specific attention should be placed on the motivation and purpose since the contexts for the use of the information may vary – e.g. the balance of policy focus between use and conservation may vary between ecosystem and species levels.

In retrospect, one accounting reason for the focus on ecosystems in the SEEA EEA is that since they have the potential to be mapped spatially in a manner that completely covers a selected study area (e.g. catchment, country), the resulting individual areas are amenable to the application of accounting and statistical principles in that the composition of the total area can be understood clearly. This is far more challenging from a species perspective since not all species have been documented and while many species can be monitored this, on its own, does not provide an exhaustive coverage. Conversely, no comparable, global typology of ecosystems (and thus ecosystem mapping) yet exists[4], while spatial data exist as range maps for >50,000 species and as point data for many more than this.

Nonetheless, while a focus on either species or ecosystems alone may not be a sufficient base for exhaustive coverage, there will be aspects of a focus on species which add to the sum of knowledge beyond accounting for ecosystems. In part, this relates to issues of scale and links between alpha, beta and gamma diversity. In accounting terms, accounting for species directly would likely suggest a move away from the use of spatial areas as the underpinning units and shift instead to individual species across a given range (noting that the link to species range likely provides a neat connection to ecosystem extent that can be considered further). Alternatively, given spatial areas (eg countries) could account for their contributions towards the global persistence of species. The linking feature across different accounts would then not be different ecosystem types but rather agreed species or other taxon. Designing complementary accounts in this way may be beneficial in supporting decisions in specific contexts although it is likely that, for a given area, there will be a necessary overlap in information content between species and ecosystem accounting. More broadly then, the current requirement is to better understand the potential nature of the relationship between accounting for ecosystems and accounting for species and to understand the information required for decision making to ensure appropriate accounting coverage and design.

At this point, it is important to recognise the ongoing work in this space by UNEP-WCMC who followed their 2015 release with research detailing approaches for the compilation of species accounts as described in the SEEA EEA. Building on this work seems an appropriate entry point.

## ADDITIONAL RESEARCH QUESTIONS

Beyond these more specific proposed pathways concerning the use of language and the design of species accounting, there are a number of research questions that would be beneficial to consider further such that the SEEA can take best advantage of the existing knowledge on biodiversity and design appropriate accounting solutions. The key questions noted here are:

- The best way for information on local populations of species (and ultimately genes) to be attributed to ecosystem assets and hence incorporated in the measurement of ecosystem

[4] Although this is an active area of research including in the context of the SEEA EEA revision process

condition. This question points to issues around scaling and aggregation and may also link to Criterion D in the IUCN work on the Red List of Ecosystems concerning interruption of biotic processes and interactions.

- Whether biodiversity can be considered an asset in its own right and, if so, what would it look like? (Note that this question assumes biodiversity is defined following the CBD, the author has had recent discussions indicating that the term biodiversity is also being used as a substitute for the environment or nature as a whole which in turn raises a range of semantic and communication issues)
- The nature of the link between biodiversity and ecosystem services and, in turn, to valuation.
- The links between ecosystem accounting, potential species accounting and indicators of biodiversity.
- The potential for using accounting to support the development of information on genetic diversity.

## CONCLUSION

The potential for accounting approaches to support analysis and decision making concerning biodiversity has been well recognised but there remains a lack of clarity about how the SEEA incorporates data on biodiversity and a lack of understanding of the various perspectives on biodiversity that may be relevant from an accounting perspective. In this context, this note aims to clarify the current understanding of the place of biodiversity in the broad SEEA framework and also outlines some ways gaps in understanding might be bridged, in particular through consideration of species accounting to complement ecosystem accounting. It is hoped that this note can serve as a stepping stone for further discussions.

As next steps it is proposed that:

- This note be discussed at the June 2019 Forum of Experts on ecosystem accounting and updated following that discussion for consultation with a wider audience
- Inputs be provided by the biodiversity community on (i) their data and information requirements to support analysis and decision making at different scales; and (ii) the different perspectives/interpretations of biodiversity notwithstanding the centrality of the CBD definition.
- A work program be developed concerning the development of a set of species accounts as introduced in this note.

## REFERENCES

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