Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services

**Plenary of the Intergovernmental Science-Policy
Platform on Biodiversity and Ecosystem Services**
Ninth session
Bonn, Germany, 3–9 July 2022
Item 8 (a) of the provisional agenda*

**Building capacity, strengthening knowledge foundations
and supporting policy: work programme deliverables and
task force workplans**

Information on advanced work on scenarios and models of biodiversity and ecosystem functions and services

Note by the secretariat

1.   In section V of decision IPBES-4/1, the Plenary of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) approved the summary for policymakers of the methodological assessment of scenarios and models and accepted the individual chapters of the assessment. In the same decision, the Plenary requested the Multidisciplinary Expert Panel to oversee further work related to scenarios and models, and to appoint an expert group to perform that work.

2.   At its seventh session, in decision IPBES-7/1, the Plenary adopted the rolling work programme of the Platform for the period up to 2030, which includes among its six objectives advanced work on scenarios and models of biodiversity and ecosystem functions and services (objective 4 (b)). The objective consists of providing advice to expert groups assessing the use of existing models and scenarios, and catalysing the development of new scenarios and associated models for the future work of IPBES and application in policy development, while also promoting coherence with similar work carried out by the Intergovernmental Panel on Climate Change and other bodies, as appropriate.

3.   In the same decision, the Plenary established a task force on scenarios and models of biodiversity and ecosystem services for the implementation of objective 4 (b) of the rolling work programme of IPBES up to 2030, in accordance with the revised terms of reference set out in sections I and V of annex II to the decision, and building on the work of the former expert group on scenarios and models, whose mandate ended with the seventh session of the Plenary. The Plenary requested the Bureau and the Multidisciplinary Expert Panel, through the IPBES secretariat, to constitute the task force in accordance with the terms of reference.

4.   According to its terms of reference, the task force oversees and takes part in the implementation of objective 4 (b) of the rolling work programme up to 2030, "Advanced work on scenarios and models of biodiversity and ecosystem functions and services", and acts in accordance with relevant decisions by the Plenary and its subsidiary bodies, including by building on lessons learned in the implementation of deliverable 3 (c) of the first work programme. The task force implements the work on scenarios and models based on the terms of reference for the further development of tools and methodologies regarding scenarios and models to facilitate the provision of advice to all the expert teams, in particular those working on assessments on the use of scenarios, and to catalyse the further development of scenarios and models for future IPBES assessments, as well as to guide the secretariat, including the dedicated technical support unit, in the provision of support.

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* IPBES/9/1.

The task force exchanges information and collaborates with other bodies developing relevant scenarios and models under the guidance of the Bureau. The Plenary also decided to review the mandate and terms of reference of the task force at its tenth session.

5.   The general terms of reference of the task forces, set out in annex II to decision IPBES-7/1, stipulate that each task force will, among other activities, provide a regular progress report and, in consultation with the Multidisciplinary Expert Panel and the Bureau, develop and update a workplan that sets out clear milestones and deliverables with regard to the relevant topics and objectives of the rolling work programme up to 2030 for periodic consideration by the Plenary. In section V of decision IPBES-8/1, the Plenary welcomed the progress made by the task force on scenarios and models in the implementation of objective 4 (b) of the work programme of the Platform up to 2030 and approved the interim workplan of the task force for the intersessional period 2021–2022, as set out in annex VII to the decision.

6.   Work programme deliverables for objective 4 (b), a workplan for the task force for the intersessional period 2022–2023 and a draft workplan for the intersessional period 2023–2024 are presented in annex V to document IPBES/9/10. An overview of activities carried out by the task force since the eighth session of the Plenary is set out in the report of the Executive Secretary on progress in the implementation of the rolling work programme up to 2030 (IPBES/9/4).

7.   The annex to the present document provides further information on activities carried out by the task force in addressing its mandate. Appendix I sets out the nature futures framework developed by the task force and preliminary methodological guidance on how the framework can be used for scenario development, for information of the Plenary. Appendix II sets out a glossary of terms used in the nature futures framework. Appendix III sets out a list of events related to the nature futures framework. Appendix IV contains a list of available literature on the nature futures framework. The annex and the appendices to it are presented without formal editing.

Annex*

Information on advanced work on scenarios and models of biodiversity and ecosystem functions and services

I. Membership of the task force

1. The Multidisciplinary Expert Panel and Bureau, at their 13th meetings selected the members of the task force in line with its terms of reference set out in annex II to decision IPBES-7/1.

2. Since the eighth session of the Plenary, members of the task force Dolors Armenteras and Polina Shulbaeva, stepped down from the task force and were replaced by Claudia Munera-Roldan and Maria Gabriela Palomo, ensuring regional and gender balance within the task force.

3. The current composition of the task force comprises:

Name	Country	Function
Shizuka Hashimoto	Japan	Task force co-chair, member of the Multidisciplinary Expert Panel
Carolyn Lundquist	New Zealand	Task force co-chair, expert
Douglas Beard	United States of America	Bureau member
Rovshan Abbasov	Azerbaijan	Member of the Multidisciplinary Expert Panel
Mariteuw Chimere Diaw	Senegal	Member of the Multidisciplinary Expert Panel
Khaled Allam Harhash	Egypt	Expert
Mekuria Argaw Denboba	Ethiopia	Expert
Laura Pereira	South Africa	Expert
Sathyapalan Jyothis	India	Expert
Dandan Yu	China	Expert
Lilibeth Acosta-Michlik	Philippines	Expert
Ali Kerem Saysel	Turkey	Expert
Ramon Pichs-Madruga	Cuba	Expert
Maria Gasalla	Brazil	Expert
Garry Peterson	Canada	Expert
Henrique Pereira	Portugal	Expert
William Cheung	Canada	Expert
Paul Leadley	France	Expert
Paula Harrison	United Kingdom of Great Britain and Northern Ireland	Expert
Sylvia Karlsson-Vinkhuyzen	Sweden	Expert
Ana Paula Dutra De Aguiar	Brazil	Expert
Maria Gabriela Palomo	Argentina	Expert
Claudia Munera-Roldan	Colombia	Expert
América Paz Durán	Chile	Fellow
Jan Kuiper	The Netherlands	Fellow
HyeJin Kim	Republic of Korea	Fellow
Ghassen Halouani	Tunisia	Fellow
Brian Miller	United States of America	Fellow

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* The annex has not been formally edited.

4.   PBL – the Netherlands Environmental Assessment Agency, which had hosted the technical support unit for the Assessment of Scenarios and Models and for the expert group on scenarios and models that had been mandated to work between the fourth and seventh sessions of the Plenary, was selected by the Bureau at its 13th meeting to also host the technical support unit to support the task force under the 2030 rolling work programme until the tenth session of the Plenary.

II.   Report on progress

5.   This section sets out activities undertaken by the task force between June 2021 and March 2022 under objective 4 (b), advanced work on scenarios and models of biodiversity and ecosystem functions and services.

A.   Deliverable 1: Provide support to IPBES assessments on scenarios and models

6.   The task force distributed the call for nominations for authors and fellows for the nexus and transformative change assessments through relevant networks to encourage the application of experts on scenarios and models.

7.   The task force reviewed the second order draft of the chapters and first order draft of the summary for policymakers of the assessment of the sustainable use of wild species and disseminated the invitation to review through relevant networks.

8.   The task force reviewed the draft scoping document for the business and biodiversity assessment and disseminated the invitation to review through relevant networks.

9.   The task force reviewed the second order draft of the chapters and first order draft of the summary for policymakers of the invasive alien species assessment and disseminated the invitation to review through relevant networks.

10.   In addition, in accordance with the workplan approved by the Plenary at its eighth session, the task force has continued to catalyse the production of publications by the scientific community to inform upcoming assessments, including work on a special issue of the journal "Sustainability Science", 'Operationalizing the Nature Futures Framework to catalyse the development of nature-future scenarios'.

11.   A presentation on the development of the nature futures framework and its methodological guidance was recorded in collaboration with the technical support unit for capacity-building, as capacity-building material on scenarios and models for authors of future assessments, such as the nexus and transformative change assessments. The video includes subtitles in the six official United Nations languages and was made available as background material for the external review of the draft nature futures framework and its methodological guidance (6 September – 31 October 2021).

12.   A webinar was organized on 8 April 2022 to inform interested participants about the BES-SIM modelling exercise that provided input to the IPBES Global Assessment of Biodiversity and Ecosystem Services.

B.   Deliverable 2: Catalyse the further development of scenarios and models for future IPBES assessments

13.   As part of the further development of the nature futures framework, the documentation on the nature futures framework and its methodological guidance has been revised based on the comments received during the external review (6 September – 31 October 2021). The revised version of the full document is set out in appendix I. Section 2 of the document is also reproduced in annex VI to document IPBES/9/10.

14.   As part of the external review process, consultations regarding the draft nature futures framework and methodological guidance were organized, including:

       (a)   An online dialogue with national focal points in two sessions on 4 October 2021 (in collaboration with the task force on capacity-building);

       (b)   An online dialogue with stakeholders, such as the wider scientific community, including experts on narrative approaches from the humanities and social science in three sessions on 6 October 2021 (in collaboration with the task force on capacity-building);

(c)   An online indigenous and local knowledge dialogue in three sessions on 28, 29 and 30 September 2021, and a plenary session on 19 October 2021 (in collaboration with the task force on indigenous and local knowledge).

15.   As a response to questions raised during the eighth session of the Plenary about the amount of literature already available on the nature futures framework, as well as to an inquiry regarding the involvement of stakeholders and experts in the development of the nature futures framework, an up-to-date literature overview is made available in appendix IV. The overview was prepared with the support of the technical support unit for knowledge and data.

16.   This overview does not include a number of manuscripts in preparation, detailing the development of the nature futures framework and its methodological guidance, for example, Duran, et al. (in review), "Bringing the Nature Futures Framework to life: Creating a set of illustrative narratives of nature futures". This publication includes the further refinement of illustrative examples of nature futures (referred to as "narratives") to provide the wider scientific community with examples of how the nature futures framework could be used to imagine new desirable futures for nature.

17.   In order to further support case study exercises by modelling groups to test the application of the nature futures framework, the task force organized the second part of the modelling workshop held in January 2021, on 25 and 28 April 2022, online. The same participants that attended the first part of the workshop were invited to participate in this second part.

C.   Other task force activities

18.   The third meeting of the task force on scenarios and models was held online on 8, 9 and 10 November 2021, in sessions of 3.5 hours. During the meeting, the task force discussed the comments received during the external review of the nature futures framework (6 September – 31 October 2021) and organized the process of revising the text on the nature futures framework and its methodological guidance. Furthermore, task force members discussed a draft concept note for the second part of the modelling workshop (April 2022), as well as the draft workplans for the intersessional periods of 2022–2023 and 2023–2024.

III.   Additional information on the workplan for the intersessional period 2022–2023

19.   The workplan for the period between the ninth and tenth sessions of the Plenary (intersessional period 2022–2023) is presented to the Plenary for approval in IPBES/9/10. Additional information on the workshop proposed as part of the workplan is provided below.

20.   A three-day workshop will be organized in October 2022 on the nature futures framework methodological guidance. The objectives of the workshop will be to discuss the current draft of the nature futures framework methodological guidance and to collect feedback on its applicability. The workshop will also serve to catalyse the further development of qualitative and quantitative scenarios which can provide valuable input for future IPBES assessments. In addition to the draft nature futures framework methodological guidance (as presented in appendix I), the workshop will build on the feedback received during the second part of the modelling workshop (April 2022) and during a dialogue workshop on indigenous and local knowledge and scenarios (September 2022). Focus points for the workshop will be:

(a)   Sharing examples on and lessons learned from the use of the methodological guidance;

(b)   Learning and discussing how to use and combine the 'building blocks' (elements) in the methodological guidance in practice to develop a scenario (common/specific features, narratives, modelling, indicators);

(c)   Discussing current methodological gaps to further operationalize the nature futures framework and add to the methodological guidance, e.g., the use of indicators and multiple knowledge systems in assessing social-ecological feedbacks;

(d)   Discussing how the nature futures framework adds value to policy and other decision-making processes, e.g., the emerging post-2020 global biodiversity framework and Sustainable Development Goals. How can the framework be used to identify and fill knowledge gaps for the provision of policy-relevant data and information?

21.   The workshop will be held as an in-person meeting or hybrid event. It will include about 20 - 60 participants depending on whether it will be organized online, hybrid or in person (this excludes members of the task force and its representatives of Multidisciplinary Expert Panel and Bureau).

Participants will include modellers, experts on social sciences and the humanities, policymakers, indigenous and local knowledge experts and experts on indigenous and local knowledge.

22.   As this methodological guidance of the nature futures framework is still evolving, the workshop aims to lead to its further development and uptake by broader scientific and practitioner communities.

Appendix I

The nature futures framework and its methodological guidance

Background

1.   In order to catalyse the further development of scenarios and models for future IPBES assessments, the former IPBES expert group and current IPBES task force on scenarios and models produced the nature futures framework (NFF) with input from diverse stakeholder groups. The NFF is compatible with the IPBES conceptual framework and provides a tool for the development of future scenarios of nature and nature's contributions to people. The framework was developed in direct response to the conclusions of the Methodological Assessment of Scenarios and Models, which identified limitations of existing scenario approaches in their usefulness for biodiversity and ecosystem services, particularly in their ability to incorporate policy objectives related to nature conservation and human wellbeing. To address these issues, input from stakeholder groups and modellers was collected through more than 10 workshops (held between 2016 and 2021), which resulted in the development of the NFF. The NFF provides a framework for the scientific community to develop new scenarios for future IPBES assessments, and for the modelling communities to develop models to identify the impact of such scenarios on biodiversity and nature's contributions to people.

2.   At its eighth session, in decision IPBES-8/1, the Plenary approved the interim workplan of the task force on scenarios and models for the intersessional period 2021–2022, setting out a process to collect feedback on the NFF and the methodological guidance through an external review and consultations with Governments, the wider scientific community, including experts in social science and humanities, as well as modelling groups, and with experts on indigenous and local knowledge and representatives of indigenous peoples and local communities.

3.   The document below provides the description of the NFF developed by the task force, and preliminary methodological guidance on how the framework can be used for scenario development. These materials were made available for external review from 6 September 2021 to 31 October 2021 (8 weeks). To support the review, online dialogues were held. This document was revised based on the comments received. Section II of this document is also reproduced in document IPBES/9/10.

I. Introduction: how scenarios are used in policy- and decision- making on biodiversity and ecosystem services

> **The nature futures framework (NFF) in a nutshell**
>
> Scenarios and models for biodiversity and ecosystem services are powerful tools to support decision-making. Decisions are made in the context of value systems and while people frequently ascribe different types of values to nature, existing scenario approaches are often limited in their ability to incorporate diverse values (section I). Following requests for more plurality of value perspectives on nature, the former IPBES expert group and current task force on scenarios and models have developed the NFF, with input from a variety of stakeholders and scientists (section II). Within the framework, the plurality of human-nature relationships is represented within a triangle, which can be used to guide the development of transformative nature-centered multiscale scenarios. The methodological guidance of the framework (section III), which is still under development, consists of a set of tools, which illustrate how the NFF could be used in practice to develop novel scenarios that incorporate different value perspectives on nature and nature's contributions to people. The tools are presented in four sections: In the first section, the concepts of common and specific features are introduced as elements of narratives or qualitative scenarios that can be used to imagine and build scenarios at particular locations within the NFF. The second section of the methodological guidance focuses on the process of developing narratives and includes a set of six illustrative narratives created to reflect six specific locations within the NFF triangle. The third section presents indicators as a tool to reflect these new NFF scenarios and the diversity of values and value perspectives. A fourth section of the methodological guidance discusses current developments in modelling the NFF. In addition, a range of potential applications of the NFF at the global and local levels and ways to adapt existing scenario frameworks to the NFF are presented as examples (section IV). Finally, knowledge gaps are introduced, explaining which aspects of the methodological guidance could benefit from further elaboration, or could be added to the current methodological guidance (section V).

1.1 Use of scenarios and models

Scenarios and models of changes in biodiversity and ecosystem services are powerful tools for informing decision-makers and other stakeholders on potential future impacts of changes across scales on nature, nature's contributions to people and good quality of life.[1] In this context, and in line with the IPBES conceptual framework, scenarios are alternative pathways to possible futures for one or more key components in a system, particularly for drivers of change in nature and nature's contributions to people, including alternative policy or management options (IPBES, 2016a; Díaz et al., 2018). Models are qualitative or quantitative representations of key components of a system and of relationships between those components, and can be used to translate scenarios of possible futures for drivers of change or policy interventions into projected consequences for nature and nature's contributions to people (IPBES, 2016a). In combination, scenarios and models can play important roles in relation to the major phases of the policy cycle, which are (i) agenda setting, (ii) policy design, (iii) policy implementation and (iv) policy review as described in the Methodological Assessment of Scenarios and Models (IPBES, 2016b, figure SPM.2). "Exploratory scenarios" can contribute to problem identification and agenda setting by examining a range of plausible futures, while "intervention scenarios" can contribute to policy design and implementation by evaluating alternative policy or management options – through either "target-seeking" or "policy-screening" analysis (IPBES, 2016b, Figure SPM.2). Scenarios and models have been used in the IPBES Global Assessment (IPBES, 2019a; 2019b) and Regional Assessments of Biodiversity and Ecosystem Services (IPBES, 2018a; 2018b; 2018c; 2018d) to provide assessments of the current status of biodiversity and ecosystem services, and to explore projections under different potential futures.

The Global Assessment Report indicates that the decline of biodiversity and ecosystem services is projected to continue or worsen in many future scenarios that consider rapid human population growth, unsustainable consumption and declining production (for example, see figure SPM.8 of the

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[1] "Nature", "nature's contributions to people" and "good quality of life", as well as "instrumental values", "intrinsic values" and "relational values", are terms used in the IPBES conceptual framework, in the preliminary guide on values and throughout IPBES assessments and documents (see Díaz et al., 2015; Pascual et al., 2017; Díaz et al., 2018 for further details). "Nature" embodies different concepts for different people, including biodiversity, ecosystems, Mother Earth, systems of life and other analogous concepts. "Nature's contributions to people" broadly captures different concepts, such as ecosystem goods and services and nature's gifts. Both nature and nature's contributions to people are vital for human existence and good quality of life (human well-being, living in harmony with nature, living well in balance and harmony with Mother Earth, and other analogous concepts).

IPBES Global Assessment Report (IPBES, 2019a; 2019b)). In contrast, scenarios with assumptions of low-to-moderate human population growth across scales, low carbon growth, a circular economy, and transformative changes will better support long term sustainability and good quality of life (IPBES, 2019a, figure SPM.8; 2019b).

1.2 Limitations of current scenarios and models

As pointed out in the IPBES Methodological Assessment of Scenarios and Models (IPBES, 2016a), most existing scenario approaches for biodiversity and nature's contributions to people have a number of shortcomings. The obvious main limitation is the extent of knowledge about the properties of nature and of its components, and about the interactions and feedback processes associated with those components. Most existing scenario approaches, especially at the global and regional scales, have been developed to address climate change issues rather than biodiversity and ecosystem services issues per se, and are limited to assessing the impacts of drivers on states of nature and nature's contributions to people. They often consider biodiversity gains or losses as an endpoint, rather than recognizing the full range of interconnections and feedback between nature and people that are central to the IPBES conceptual framework (Seppelt et al., 2020). Existing scenario approaches are also limited in their ability to incorporate diverse values, norms and policy objectives related to nature conservation and good quality of life (IPBES, 2016a). As a result of limited stakeholder involvement, scenarios have often under-represented the diversity of worldviews and indigenous and local knowledge (Obermeister, 2019). Furthermore, institutional barriers to the use of scenario outcomes and the timing of presenting scenarios to governments (e.g., "windows of opportunity", see Kingdon, 1984) may need to be addressed, with a view to increasing the chance that scenario-related insights are taken up in political agendas.

All models have strengths and weaknesses (IPBES, 2016a), and it is therefore vital that their capacities and limitations be carefully evaluated and communicated in assessment and decision-making processes (see Sietz & van Dijk 2015; Fonte et al., 2012). Limitations of current scenarios and models are not necessarily a reflection of deficiency in approach – rather, they are a reflection of the degree of complexity involved in solving current problems. Existing approaches often explore the impacts of direct and indirect drivers on nature and people (e.g., adverse climate change impacts on biodiversity and ecosystem services), rather than focusing on the transformative changes required to achieve international goals for both nature and people (e.g., the emerging post-2020 global biodiversity framework (CBD, 2021); nationally determined contributions under the Paris Agreement and the Sustainable Development Goals).

1.3 Addressing shortcomings for the development and use of scenarios and models in the context of nature and nature's contributions to people

Addressing the shortcomings of existing scenario approaches for nature and nature's contributions to people at different scales requires better integration of the feedback processes between nature and good quality of life for people. It also requires recognition and inclusion of both synergies and trade-offs between the targets of the emerging post-2020 global biodiversity framework, the goals of and means for responding to climate change under the Paris Agreement, and the Sustainable Development Goals. Participatory approaches are also required to involve stakeholders in the development of future scenarios for nature and people and to incorporate multiple value perspectives and different pathways to achieve societal goals (IPBES, 2016a; Rosa et al., 2017; Pereira et al., 2020; Kim et al., 2021, in preprint; Lundquist et al., in prep.). Inclusion of values of nature can enhance the development of new global scenarios for nature and nature's contributions to people, as it allows the diversity of human-nature relationships to inform context- and place-specific policy options based on locally held values of nature (Braun & Castree, 2005; Cronon, 1996; Descola, 2013; Head, 2016; Latour, 2004; Robin, Sörlin, & Warde, 2013).

To address these requirements, the IPBES Plenary mandated the expert group (2016 - 2019) and task force (2019-present) on scenarios and models to catalyse the development of new scenarios that can better inform policymaking for nature and nature's contributions to people (see terms of reference of the task force, annex II to decision IPBES-7/1), building on the IPBES Methodological Assessment of Scenarios and Models (IPBES, 2016a). To capture the plurality of value perspectives on nature, the former expert group and current task force have worked on a new framework for the development of nature-centred scenarios, called "the nature futures framework" (NFF). Having a framework that is applicable across different scales, regions and value perspectives allows the development of comparable new scenarios to better support future IPBES assessments.

1.4 Development of a new framework to promote the effective use of scenarios for nature and nature's contributions to people

The NFF is designed to help its users to consistently articulate a variety of desirable futures that focus on human-nature relationships. Specifically, the framework aims to catalyse the development of scenarios that focus on achieving a world that realizes the 2050 Vision for Biodiversity of "Living in Harmony with Nature" (CBD, 2010) while considering the 2030 Agenda for Sustainable Development and its Sustainable Development Goals. These visions and goals require reversing declines in biodiversity and nature's contributions to people (Pereira et al., 2020). There are many ways of "living in harmony with nature", depending on what particular value perspectives on nature are considered to be "harmony". The framework is explicitly designed to include multiple values of nature in scenarios and models, in order to allow consideration of alternative ways to achieve the 2050 Vision for Biodiversity and the Sustainable Development Goals. Positive or desirable nature futures represent scenarios where biodiversity and nature's contributions to people are improved in one or more value perspectives in relation to the current situation.

Creating scenarios and models based on multiple values can make them more inclusive. The explicit inclusion of multiple values of nature enables scenarios and models to better consider and incorporate indigenous and local knowledge systems and values, as well as to better consider socio-cultural contexts and alternative governance and economic systems, diverse methods of sustainable resource utilization and diverse approaches to biodiversity conservation. The IPBES task force on scenarios and models is developing methodological guidance on how to apply the NFF to the development of quantitative and qualitative scenarios for a diversity of settings and scales.

The review of the framework has been undertaken in close collaboration with other IPBES work streams; for instance, the task force on scenarios and models organized online dialogues on indigenous and local knowledge and scenarios together with the task force on indigenous and local knowledge, and online dialogues for national focal points and for stakeholders together with the task force on capacity building (see annex I.B for further details). The task force on scenarios and models took into account the work of completed IPBES assessments, as well as the scoping reports of the nexus and transformative change assessments.

The present document describes progress by the task force on scenarios and models to date, namely it:
1. Describes the foundations of the NFF (section 2);
2. Outlines the evolving set of tools for using the NFF to develop qualitative and quantitative scenarios (section 3);
3. Illustrates a selective set of (potential) NFF applications catalysed to date, particularly in support of IPBES assessments (section 4);
4. Identifies knowledge gaps and future activities related to the further refinement and use of the NFF (section 5).

The present document does not present actual scenarios developed based on the NFF. Scenario development by the scientific community with models and other tools, and the narrative development and refinement with stakeholders, still need to be carried out and are planned for the next four years, with final outputs available in time for use in a potential second Global Assessment of Biodiversity and Ecosystem Services (figure 1).

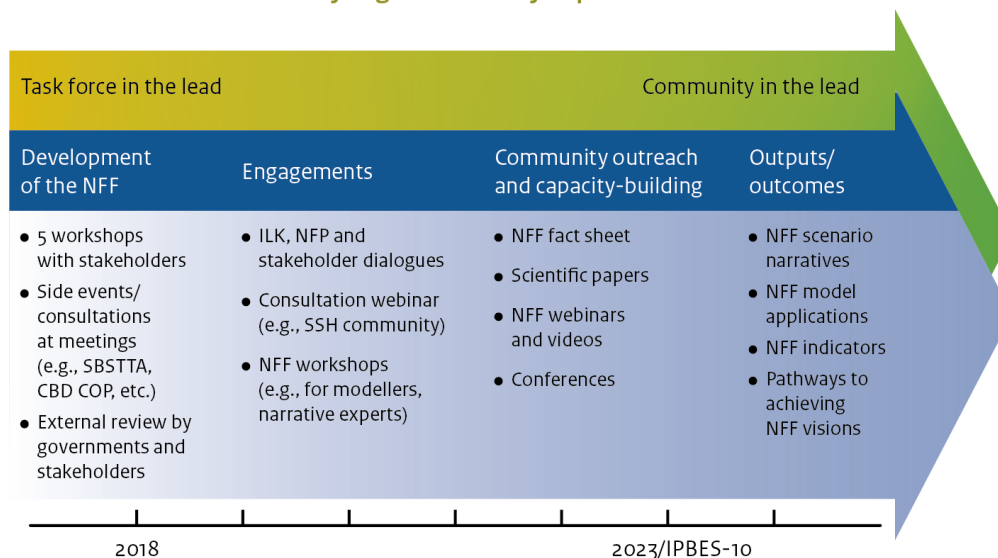**Envisioned timeline for catalysing a community of practice**

Task force in the lead			Community in the lead
Development of the NFF	Engagements	Community outreach and capacity-building	Outputs/ outcomes
• 5 workshops with stakeholders • Side events/ consultations at meetings (e.g., SBSTTA, CBD COP, etc.) • External review by governments and stakeholders	• ILK, NFP and stakeholder dialogues • Consultation webinar (e.g., SSH community) • NFF workshops (e.g., for modellers, narrative experts)	• NFF fact sheet • Scientific papers • NFF webinars and videos • Conferences	• NFF scenario narratives • NFF model applications • NFF indicators • Pathways to achieving NFF visions

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Figure 1. The envisioned process for catalysing a community of practice for developing scenarios based on the NFF over time. The yellow-green colour gradient represents transitions in the lead of the listed activities from the IPBES task force on scenarios and models to the broader community. While the weight of the involvement of the task force is transferred to the broader community over time, there has been strong stakeholder engagement from the onset of the process. The blue arrow presents the activities of the task force on scenarios and models over time. It is anticipated that community engagement and outreach activities will lead to the formation of research consortiums and funded research projects that will achieve the goal of creating multi-scale (from local to global) scenarios based on the NFF, which would continue to be developed and refined over the long term. For detailed information on the engagements of the task force up to date, please see annex I.B. *Abbreviations:* CBD – Convention on Biological Diversity; COP – Conference of the Parties; ILK – Indigenous and local knowledge; NFF – nature futures framework; NFP – National Focal Points, SBSTTA – Subsidiary Body on Scientific, Technical and Technological Advice; SSH – Social sciences and humanities.

II.   Foundations of the nature futures framework

2.1 History and contribution of the NFF to catalyse the development of scenarios and models

The NFF succinctly describes a diverse set of desirable futures for nature and people that differ in their emphasis on the types of values that people assign to nature (Pereira et al., 2020). It takes into consideration the call for plural values of nature and nature's contributions to people to be recognized, referring to the preliminary guide regarding diverse conceptualization of multiple values of nature and its benefits, including biodiversity and ecosystem services, developed under the first IPBES work programme. This preliminary guide on values, as well as the ongoing IPBES values assessment, are underpinned by the view that the use of diverse conceptualizations of multiple values of nature and its benefits to people must be acknowledged and fostered in order to adequately address the challenge of global sustainability (Pascual et al., 2017; IPBES, 2015). Whereas both the ongoing IPBES values assessment and the NFF incorporate values of nature, they have different purposes: the former assesses existing literature and describes different approaches to the conceptualization of values of nature, whereas the latter serves as a starting point for co-development of scenarios.

Taking into account the properties, interactions and feedback that operate in nature, the NFF emerged from stakeholder consultations that gathered a wide range of visions of desirable futures for biodiversity and people (Lundquist et al., 2017; Pereira et al., 2020). It reflects three primary value perspectives of nature, embracing the diversity of human-nature relationships. The term "value perspectives of nature" is used to encapsulate the diversity of values that humans assign to nature, while focusing primarily on broad-scale differences between intrinsic, instrumental and relational values. This framework allows those involved in scenario-building to recognize and address, in a more explicit manner, plural values ascribed to nature and nature's contributions to people, which conventional scenario-building methods often fail to capture. The methodological guidance primarily targets research communities and other knowledge holders who work towards providing new research, and thus new literature serving the upcoming IPBES assessments. In addition, the qualitative illustrative narratives and other examples such as those presented in the boxes in section 4.2 may also

inspire policy-makers and other stakeholders. The framework places values that humans assign to nature at its core. The underlying assumption for formulating any type of positive future vision of nature is that nature is valued much more in the future, but the reasons why it is valued – the underlying value perspective – can vary widely. The diverse ways in which humans value nature can be used to develop a diversity of possible future scenarios. The framework is novel in that it explicitly provides a space for inclusion of relational values within a global biodiversity scenarios framework, acknowledging that relational values, such as cultural identity, sense of place, traditions and reciprocity with nature, are often poorly represented or marginalized in assessments of biodiversity and ecosystem services.

2.2 Description of the NFF

The NFF represents value perspectives on human-nature relationships within a triangular figure (figure 2). Each corner of this triangle illustrates the orientation towards one of the following three value perspectives on the relationship between humans and nature: intrinsic: nature for nature; relational: nature as culture; and instrumental: nature for society (see glossary, annex I.A). The space within the triangle represents a continuum or gradient between these three value perspectives. As such, all the potential locations within the triangle relate to each of the three corners and thus offer some combination of all three value perspectives. It is important to bear in mind that the vertices, or corners, of the triangle offer extreme cases of what could be considered a "desirable future for nature" that are limited to a particular perspective. These "desirable" futures may be place- or context-specific, subject to local cultures and values. Examples of "desirable futures for nature" are provided in the boxes in section 4.2 of this document. The framework does not aim to identify any particular narratives or scenarios as preferred based on their location in the NFF, reflecting the fact that value preferences vary culturally and geographically. The vertices of the framework may be more representative in the local context, reflecting particular value perspectives that are locally specific, whereas the centre of the triangle may be reflective of regional or global contexts, incorporating multiple value perspectives (Lundquist et al., in prep; Kim et al., 2021, in preprint).

Nature Futures Framework

Nature as culture
Relational values
People in harmony with nature
Reciprocity

Nature for society
Instrumental values
Natural capital

Nature for nature
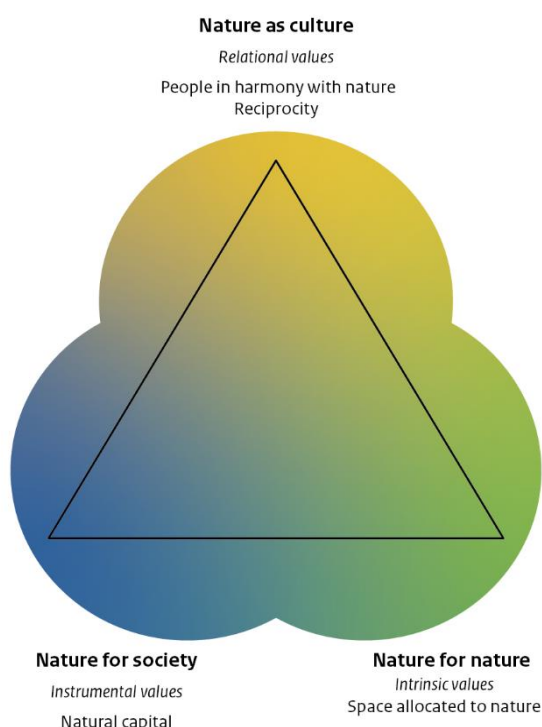*Intrinsic values*
Space allocated to nature

Figure 2. The NFF presents three value perspectives of nature in a triangle: intrinsic: nature for nature; relational: nature as culture; and instrumental: nature for society. The coloured circles associated with each value perspective blend together where they intersect, showcasing that they are not mutually exclusive. Desirable futures for nature are represented within the triangle, whereas undesirable states for nature and people are represented by the space outside the triangle. The framework is based on the understanding that there may be undesirable futures that perform well for a particular aspect of nature or nature's contributions to people, but may result in negative consequences for many others. The lines of the triangle indicate that the boundary between desirable and undesirable futures is often context- or place-specific. As there is no hierarchy among the three value perspectives, users may choose which value appears at the top of the triangle.

In the **"nature for nature"** perspective, people view nature as having intrinsic value, and value is placed on the diversity of species, habitats, ecosystems, and processes that form the natural world, and on nature's ability to function autonomously. This perspective has dominated much of the conservation movement's concern about the extinction crisis and the protection of wilderness, and is well represented in the Aichi Biodiversity Targets for protected areas and some of the draft goals of the emerging post-2020 global biodiversity framework under the Convention on Biological Diversity (CBD, 2021) and within concepts such as "Half-Earth" (see Box 4) and rewilding.

The **"nature as culture"** perspective primarily highlights relational values of nature, where societies, cultures, traditions and faiths are intertwined with nature in shaping cultural landscapes (Himes & Muraca, 2018). This perspective emphasizes people living in harmony with nature and is often exemplified in spiritual and other non-material human-nature relationships such as cultural identity, sense of place and sense of belonging. The "nature as culture" perspective is not limited to indigenous and local knowledge systems, and is increasingly recognized worldwide by initiatives that promote humans reconnecting with nature within urban and rural landscapes, traditional lifestyles, and nature's contributions to mental health (e.g., Japanese concepts of *satoyama* and *satoumi*, which represent places where human presence is integrated in such a way that it promotes the wellbeing of the natural landscapes). Culture and cultural connections with nature are not restricted to this perspective; rather, "nature as culture" is meant to emphasize that nature and culture are inseparable and that people are an integral part of, not separate from, nature.

The **"nature for society"** perspective highlights the utilitarian benefits and instrumental values that nature provides to people and societies. This view is reflected in concepts such as ecosystem services, natural capital, green infrastructure and nature-based solutions, which cast nature as a provider of services to society (UNEP, 2021). A wide variety of approaches exist to quantify the benefits that people receive from nature, such as food production and water filtration, and their influence on human health. Many of these instrumental values form direct connections between nature and society and are represented within the Sustainable Development Goals, the Aichi Biodiversity Targets and the emerging post-2020 global biodiversity framework. Many nature-based solutions (e.g., saltmarsh or mangrove restoration for carbon sequestration) exemplify the instrumental benefits of nature.

While the NFF builds on the concepts of intrinsic, relational and instrumental values, the three value perspectives do overlap to some degree and the framework allows for their coexistence, addressing some of the criticisms expressed by Piccolo (2017) about value dimensions. The framework allows recognition of the diversity of ways in which people define "nature", and of the understanding that knowledgescapes, interactions and identity influence the values that individuals attribute to nature (Berghöfer et al., 2020). "Nature for nature" both represents intrinsic values and indirectly provides instrumental values though the non-material benefits of healthy ecosystems. "Nature for society" is dominated by the direct and indirect use of a subset of instrumental values, while "nature as culture" captures the relational values including the non-material contributions of nature. Examples of where the overlap between "nature for society" and "nature as culture" is strong include mental health and recreational benefits of nature. The intrinsic value of nature is integral to many cultures, which is where "nature for nature" and "nature as culture" meet each other.

The state of the planet or any place on the planet can be assessed across these three perspectives (figure 3). The goal for scenario development with the NFF is to improve the state of a place across one or more of these three perspectives. Therefore, one aims to move a place from a current condition, one that is often degraded from one or more of these perspectives (Figure 3), to a higher score. As one approaches high scores in one of the perspectives, there may be trade-offs with others. At the global level, one may be speaking of multi-decadal timescales (e.g., 2020–2050), while at the local scale, multi-year timescales for scenario development may be more adequate (e.g., 5–10 years).
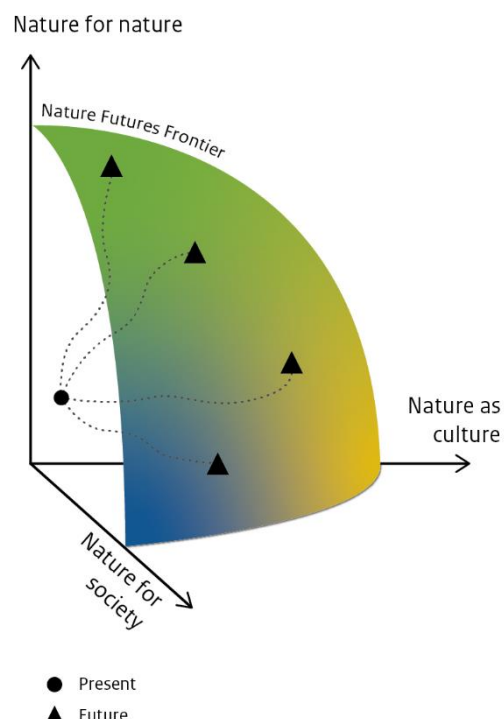
Nature Futures Framework

Figure 3. A conceptual illustration of how the NFF can be used to define pathways toward sustainable futures. Each axis corresponds to one of the three value perspectives for nature. In this example, actions take place to improve nature and nature's contributions to people across one or more of the value perspectives toward a more desirable nature futures frontier. Increasing scores for one value perspective may require trade-offs with another value perspective (modified from Kim et al., 2021, in preprint).

2.3 What is unique in the NFF?

The NFF can be used to develop scenarios that represent a diversity of futures based on different value perspectives for nature, which is novel within a framework for global environmental scenarios. While the NFF is intended to catalyse the development of scenarios that can be compared, it does not pre-define specific characteristics for individual scenarios; rather, it allows the development of place- and context-specific scenarios that represent local and regional priorities, ecologies and values. The use of a single framework combining different value perspectives for nature facilitates its application to a diversity of regional and socio-economic contexts, where common and specific features (see next section) allow for comparison across individual scenarios. To apply the framework, users can develop NFF-based scenarios within a range of socio-cultural, economic and political contexts and across a wide range of spatial scales, which may identify pathways towards desirable futures that achieve the emerging post-2020 global biodiversity framework targets and the Sustainable Development Goals (IPBES, 2016a). The specificity of individual scenarios can thus be easily translated to local conditions and applied to issues of interest to local policy makers.

The NFF can be differentiated from scenario approaches such as representative concentration pathways (commonly known under the acronym RCPs) and shared socioeconomic pathways (commonly known under the acronym SSPs), developed in support of the assessments of the Intergovernmental Panel on Climate Change (van Vuuren et al., 2014). The Shared Socioeconomic Pathways - Representative Concentration Pathways framework is prescriptive in terms of outcomes for greenhouse gas concentrations and many other direct and indirect drivers of climate change, such as human population growth, economic growth and agricultural productivity (O'Neill et al., 2017). Box 3 illustrates how the NFF can be matched across shared socioeconomic pathways and representative concentration pathways, and various efforts currently in place to use the shared socioeconomic pathways as entry points into novel NFF-based scenarios.

The NFF allows for flexibility in how international goals and policy targets are applied at local and regional scales. Even though it is not as prescriptive as the –Shared Socioeconomic Pathways - Representative Concentration Pathways framework, the NFF still allows the development of prescriptive scenarios and models for such goals and targets (e.g., for a possible 30 percent protected

area target (CBD, 2021). Where a quantitative target is suggested, the NFF gives the user the ability to specify the numerical target (i.e., percentage of area under protection and other effective area-based conservation measures), as well as the flexibility to decide which area-based conservation measures could be used and how those measures are spatially distributed. The NFF thus allows flexibility in applying the emerging targets of the post-2020 global biodiversity framework to local contexts.

III. The NFF set of tools as methodological guidance for scenario development

This section presents the NFF methodological guidance, which illustrates how the framework could be used to develop novel scenarios that incorporate the multiplicity of value perspectives for nature. The methodological guidance primarily targets research communities and other knowledge holders who work towards generating new research serving the upcoming IPBES assessments. The methodological guidance consists of four elements, which are introduced in the four subsections below: 3.1 Common and specific features; 3.2 Developing narratives; 3.3 Indicators and 3.4 Modelling. This methodological guidance, as mentioned earlier, aims to catalyse the development of new scenarios for nature, but it is not intended to be fully prescriptive, nor to provide highly specific and pre-defined characteristics for scenarios. Rather, the framework is flexible to allow its application to a variety of contexts. The methodological guidance is still evolving, and sections 3.1, 3.2, 3.3 and 3.4 will be updated as work develops.

First, the concepts of common and specific features are introduced as elements that can be used to conceptualise and build scenarios at different locations within the NFF. Common features reflect shared global goals for nature and nature's contributions to people across all NFF-based scenarios, such as halting species extinction, mitigating and adapting to climate change, and achieving the Sustainable Development Goals. In contrast, specific features reflect commonalities for scenarios at a particular location within the NFF. These specific features include descriptors of nature, nature's contributions to people, direct and indirect drivers, and other scenario elements that would be compatible with a NFF location but may differ between NFF locations. To allow for comparability of NFF-based scenarios, the concept of a 'scenario family' (see glossary, annex I.A) brings together all scenarios at that location with shared specific features that are applied within a local or regional context.

Second, the methodological guidance provides guidance for the process of developing narratives, and includes illustrative narratives created specifically to reflect six locations within the NFF (Figure Box 1). The flexibility of the framework is further demonstrated by showing how existing global scenarios could be translated to particular locations in the NFF, and how the NFF has been applied in a variety of both qualitative and quantitative contexts. It is important to emphasise that the NFF is not intended to be solely a quantitative exercise. Rather, it has been designed to enable inclusion of diverse perspectives on nature-human relationships for the future, and to also better incorporate previously marginalised values and knowledge systems in global, regional and national assessment processes. Qualitative applications of the NFF include co-creation processes at local, national, regional and global contexts involving decision-makers, indigenous peoples and local communities and other stakeholders, through participatory narrative development. Those applications are crucial to ensure that multiple value perspectives for nature are considered to allow their recognition and inclusion in decision making on what better futures for nature could be.

Third, the methodological guidance discusses indicators that can reflect these new NFF-based scenarios and the diversity of value perspectives which they represent. It includes guidance for identifying existing or new indicators for using the NFF and informing quantitative or qualitative assessments across all locations in the framework. While there are constraints in data availability and accessibility to inform indicators in some regions, global datasets for biodiversity and ecosystem services are available to inform some indicators. Work is in progress to identify and prioritize gaps in indicators, particularly indicators to represent the 'nature as culture' value perspective.

Fourth, the methodological guidance briefly discusses the initial development of approaches for qualitative and quantitative modelling of the NFF.

3.1 Common and specific features

A user may wish to start scenario development or analyses from a minimal set of features that are compatible with the NFF to build positive visions of the future, for example recent work showing the actions that are needed to achieve a positive future for biodiversity, climate change and human well-being (Leclère et al., 2020; Soergel et al., 2021, Kok et al., 2020 in preprint). In some cases, these features are common across the three NFF value perspectives ('nature for nature'; 'nature as culture'

and 'nature for society'); in other cases, the features are relatively well differentiated and are specific to a particular position in the NFF (see Figure 4). Scenarios based on positions near the centre of the NFF represent a compromise between the most highly differentiated of the three values perspectives. Both common and specific features can be either features relating to outcomes or features relating to direct and indirect drivers.

Some of the features that are common to all NFF-based scenarios are related to changes in the direct and indirect drivers that are essential for halting and reversing biodiversity loss. For example, many studies have shown that keeping global warming to below 2°C and if possible to 1.5°C, controlling invasive alien species, and substantially reducing pollution from fertilizer and pesticides are essential to achieve positive outcomes for nature and nature's contributions to people (IPBES, 2019a). As such, these are essential, common features of any scenarios and modelling efforts that intend to be compatible with the NFF. In terms of outcomes for nature and nature's contributions to people, it is possible to identify a few broad objectives that should be met by all NFF-based scenarios. For example, there is broad agreement that species extinction rates are currently much higher than in the geological past and should be brought down (IPBES, 2019a), that populations of threatened species should generally be restored (see Figure 4), or that regulating services like nature's contributions to climate change mitigation should be reinforced (Pörtner, Scholes et al., 2021).

There are many aspects of scenarios and models that may differ because they correspond specifically to a particular value perspective of the NFF. These specific features include things such as which types of species are of most concern for conservation and restoration (see Figure 4), the emphasis on strictly protected areas (e.g., more emphasis on 'nature for nature'), or the emphasis on nature and nature's contributions to people when considering the trade-offs between them (e.g., more emphasis on nature's contributions to people in 'nature for society').

Example of common and specific features related to species conservation
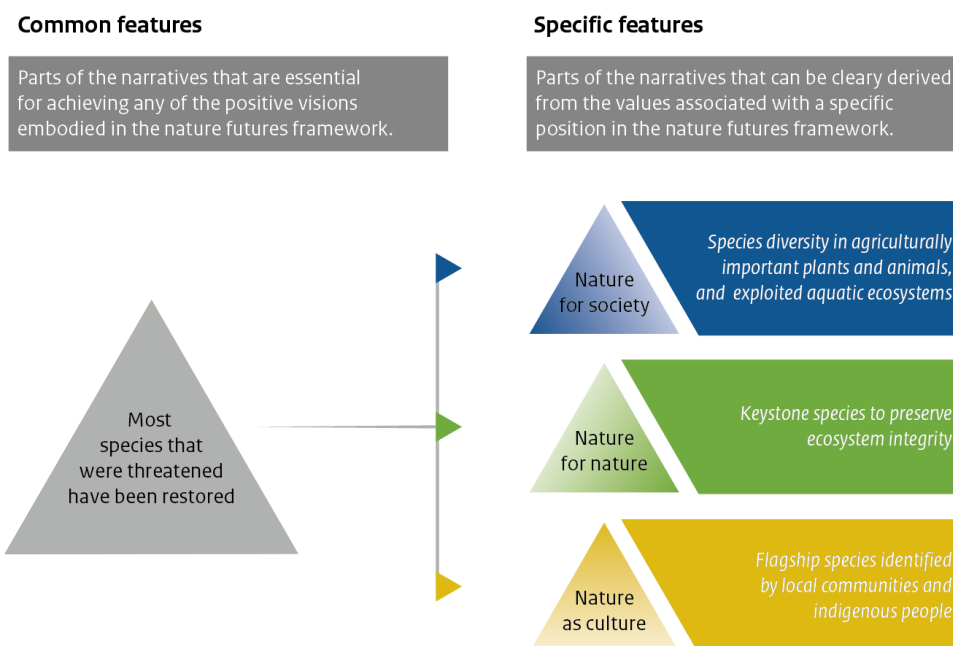

Figure 4. The concept of common and specific features illustrated by an example for species conservation. All narratives that are derived from the NFF have shared outcomes referred to as common features. In this example, the conservation of threatened species should be achieved in all visions of the NFF. Narratives are distinguished from one another by the specific features, such as the types of species that are the primary focus of conservation and restoration efforts.

Alternatively, a user may wish to start from well-defined illustrative narratives, which are primarily qualitative, detailed, descriptions of future states of nature, nature's contributions to people and good quality of life, as well as the other components and relationships of the IPBES conceptual framework. There may be multiple narratives that correspond to any given position within the NFF (hence the name 'illustrative narratives'), reflecting how different cultures, societies and geographies may

translate the NFF into a local context and a variety of future aspirations. All illustrative narratives should, however, be compatible with the common features of NFF-based scenarios described above. Illustrative narratives are a key component in translating the NFF values perspectives into quantitative and qualitative scenarios.

3.2 Developing narratives

A **narrative family** is a non-exhaustive group of narratives that correspond to a particular position within the NFF. All narratives within a narrative family should be coherent with the corresponding NFF value perspectives and specific features aligned with these. This provides a means of classifying NFF-based scenarios and other existing scenarios into groups with similar assumptions to facilitate comparison and synthesis for IPBES and other assessments. This is similar to the approach of grouping scenarios into 'scenario archetypes' that was used in the IPBES Global Assessment and Regional Assessments of Biodiversity and Ecosystem Services (Sitas et al., 2019). Narrative families could also be used to explore how different narratives for any single position in the NFF differ in terms of assumptions and outcomes for nature, nature's contributions to people, and human well-being. The most distinct narrative families are located at the three vertices of the NFF (Figure 2). Other proposed narrative families correspond to the three intermediate positions between the vertices and at the centre of the framework.

IPBES will not develop a specific set of narratives based on the NFF. Rather the IPBES task force on scenarios and models envisions that narratives will be developed by different scientific communities and other stakeholders, which can serve as input to upcoming IPBES assessments. However, the task force has developed six narratives as illustrative examples that are described briefly in Box 1 and will be explained in detail in a forthcoming paper (Duran et al., in review, see preliminary versions of these illustrative narratives in PBL, 2020). These six narratives, co-developed as part of a narrative development exercise, reflect just one of many possible narratives for particular locations in the NFF, and are not prescriptive for narratives in those locations in the NFF. The flexibility of the NFF framework allows others to create narratives that utilise elements particular to their own sociocultural, economic and political context for that particular location in the framework, within the constraints of the common and specific features for that location (Box 1).

Collaboration amongst the social sciences and humanities, modelling communities, and with stakeholders, including indigenous peoples and local communities, can be of benefit to the development of a new generation of scenarios and associated indicators, and can facilitate dialogue between different stakeholders to inform conflict resolution, and give voice to those stakeholders whose input is often marginalised in these decisions. This collaboration can assist in identifying narratives that represent the pathways for the transformative changes that are required to achieve local, regional and/or international targets for nature, nature's contributions to people and good quality of life.

BOX 1 - Brief illustrative narrative examples

Summary description of the six illustrative narratives developed by the IPBES task force on scenarios and models through an iterative, co-development process (source: Duran et al., in review; titles and characteristics are subject to change; for a full descriptions of the narratives, please refer to the paper):

Arcology

- '*Nature for nature*'

People respect and value all life on Earth intrinsically. This world is characterised by extreme land-sparing as vast areas of land and sea are strictly protected from human interventions. People live in dense self-sustaining urban areas designed to minimise the role of humans in the biosphere. Human population cannot be very high in this future.

Optimising nature

- '*Nature for society*'

A highly connected world that shares knowledge and technology to maximise efficient and sustainable utilisation of nature's contributions to people while ensuring maintenance of the key ecosystem functions that underpin them.

Reciprocal stewardship

- '*Nature as culture*'

In this world, values of reciprocity and harmony drive the relationships of humans with nature at all levels of human organisation. Biological and cultural diversity are co-conserved and co-managed across a wide range of interconnected bio-cultural systems.

Innovative commons

- Balancing '*nature for society*' and '*nature as culture*'

People have built a world of innovative ecological commons and live in interconnected green-blue cities and rural settlements across land- and seascapes. People use their local and traditional knowledge, and technology, to manage and expand the use of ecosystems and biodiversity and to also enhance their culture.

Dynamic futures

- Balancing '*nature as culture*' and '*nature for nature*'

Dynamic, connected and biodiverse ecosystems are valued to allow traditions and culture, spiritual values and connections to be re-established and new ones to be shaped. Society accommodates the dynamics of nature through both traditional and innovative lifestyles which take into consideration cultural heritage and traditional ecological knowledge, by for example, allowing space for migrations.

Sharing through sparing

- Balancing '*nature for nature*' and '*nature for society*'

People favour the utilisation of nature but also value and protect the self-regulating capacity of the biosphere as biodiversity and natural processes provide the resilience that enables humanity to stay within planetary boundaries. While sparing space for nature, remaining areas are used intensively but efficiently and sustainably.
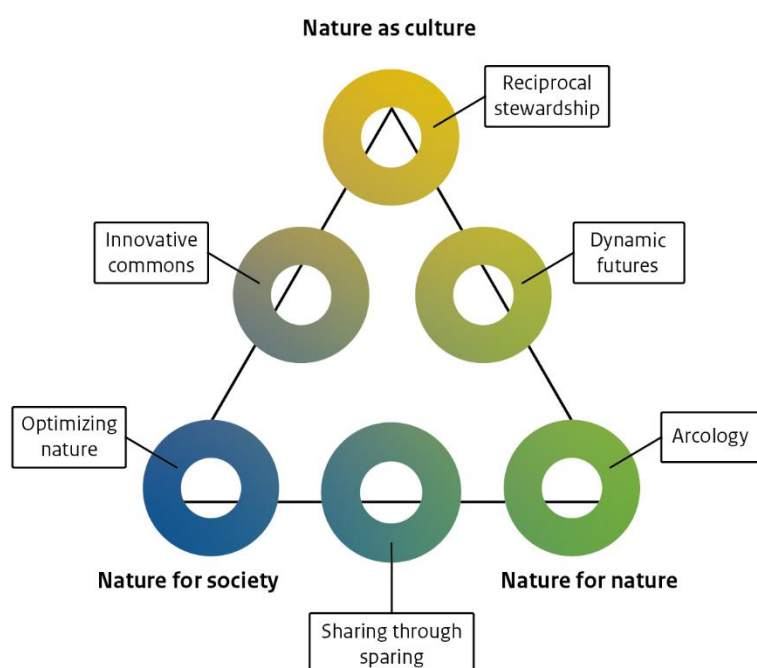

Figure Box 1. Placement of the illustrative narratives within the NFF.

3.3 Indicators

Indicators are another important component of the NFF toolbox. The use of indicators for monitoring the state of biodiversity and ecosystem services, including in the context of tracking progress towards national or global targets, is well known. Indicators (or the values underlying them) are also important components of models and scenarios, including NFF-based scenarios, where they can be used for different purposes. Firstly, indicators can be used to enable the coherent description of scenarios in qualitative or quantitative terms, also supporting the possibility to compare NFF-based narratives and scenarios. Combinations of relevant quantitative and qualitative indicators may be associated with the value perspectives of the NFF and thereby help illustrate scenarios based on the NFF. Indicators can illustrate either common or specific features of NFF-based scenarios. Secondly, indicators enable

modelling communities to quantify scenario narratives formulated using the NFF. Indicators can also be selected and formulated to assess progress toward international and national objectives such as post-2020 global biodiversity targets (CBD, 2021) and SDGs (UN, 2015). Targets can be explored with respect to particular value perspectives, and pathways to achieve these targets may differ in different NFF locations. Finally, including a diversity of qualitative and quantitative indicators can be useful in informing discussion of different policy options.

There are different ways to identify indicators in the development of NFF-based scenarios, reflecting the diversity of ways to develop these scenarios (see examples in boxes in section 4.2). Below are suggested steps for identifying indicators within a NFF-based scenarios approach:

1. Develop narratives for the desired scenario(s), following the suggestions in sections 3.1 and 3.2. Narrative development could be done by scientists but also at any scale in a co-development process with a local community, national stakeholders, etc.

2. In the description of the narratives, include both common and specific features (see, for example, section 3.1) for each scenario related to the components of the IPBES conceptual framework; direct and indirect drivers, state of nature and nature's contributions to people, institutions and governance (responses). Examples of these features include those presented in the illustrated narratives and the examples presented in section 4.

3. Produce a conceptual diagram of the various features identifying relevant social-ecological feedbacks among these components (see Figure 4 in Kim et al., 2021 in preprint).

4. Identify possible indicators for the various common and specific features, including those conceptual indicators that may not yet exist. Depending on how the scenario will be used, these could be either qualitative or quantitative indicators. A number of resources provide lists of available indicators, or indicators in development that can be explored to determine appropriate indicators, which can be aligned with one or more or of the value perspectives in the NFF (e.g., representing its specific features). For example, the specific features in Figure 4 give clear directions for the different indicators required for each value perspective: indicators of flagstone species, keystone species and agricultural species, respectively.

The selection and role of indicators in NFF-based and other scenarios vary considerably with their use and it is important to consider the constraints in data availability and accessibility for indicators that many countries (and communities) face. Specifying data is not done in this document, as qualitative scenarios may differ from quantitative in terms of data needs, and scenarios in different regions may differ in both availability and applicability of data to questions at hand. It is therefore advisable to scan for relevant indicators among the wide diversity of data that is collected regularly including those collected for other purposes, beyond nature conservation, and it is advisable to use fewer indicators (representing what is directly relevant) than many indirect or proxy indicators. When aiming to use co-developed scenarios for planning and decision making in a (local) community setting, existing data can be reviewed and used to inform indicator development.

The task force on scenarios and models aims to catalyse the use of existing indicators for application to the development of NFF-based scenarios, as well as identify potential gaps in indicators concerning balanced representation of all NFF value perspectives in new scenarios. The task force is not mandated to develop new indicators. Rather, as first steps in supporting the use of indicators for NFF-based scenarios, the task force has, in collaboration with other scientists, stakeholders and indigenous peoples and local communities, made efforts to align indicators in existing global indicator lists with the different value perspectives of the NFF, including those used for the Convention on Biological Diversity's Aichi targets, the Sustainable Development Goals, indicators made available by the Biodiversity Indicator Partnership and additional indicators derived from the essential biodiversity and ecosystem services variables[2]. This is work in progress, see Kim et al., (in prep. b); Karlsson-Vinkhuyzen et al., (in prep.) and section 5.1.

These indicators can support scenario development by providing historical and future trajectories on a range of common and specific features for each of the NFF value perspectives that can be used for scoring and mapping of systems or places within the NFF. The indicators approach followed by the

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[2] The Essential Biodiversity Variables (EBVs) cover the key dimensions of biodiversity spanning six classes (Species populations, Species Traits, Genetic Composition, Community Composition, Ecosystem Structure, and Ecosystem Function) (Pereira et al., 2013). In addition, a new framework is being developed for Essential Ecosystem Services Variables (EESVs) that provides a flexible means for measuring change in a wide range of material, non-material and cultural services that biodiversity and ecosystems provide (Balvanera et al., 2022). Both the EBVs and EESVs will include data products that can inform a wide range of policy frameworks, including the CBD, SDGs, and other multilateral environmental agreements

IPBES task force on knowledge and data and the experts of the IPBES values assessment, including indigenous and local knowledge indicators, can also be used as reference in the development of NFF-based scenarios. Indicators can be identified across the elements of the IPBES conceptual framework and across the three NFF value perspectives according to the research or policy question of interest. Then using those indicators, systems or places can be assessed to understand their status and trends towards different policy-relevant targets. As an example, prevention of species extinction could be a common feature across all NFF-based scenarios that would rely on the same indicator for species extinction rates. For specific features, indicators for species that are important for ecological processes and functions could have a greater emphasis in 'nature for nature', for species that are important for material and regulating services in 'nature as society', and for species and landscape that are important for local communities and cultural heritage in 'nature as culture' scenarios (Figure 4).

Furthermore, indicators can support the impact assessment of different interventions on reductions in impacts of direct and indirect drivers, either with indicators or interventions mapped to different NFF value perspectives (see Box 2). In some cases, these indicators may be outputs of scenarios and models. However, currently global scenarios and models do not use indicators that adequately represent all NFF value perspectives. Some 'missing' indicators relevant for global NFF-based scenarios can be inferred or derived from existing scenarios and models, but in other cases, efforts will be required to identify or develop these indicators (e.g., indicators on biodiversity and human health). In particular, the 'nature as culture' perspective requires a variety of indicators that present cultural aspects of biodiversity and people, and few are available in existing indicator sets (see section 5.1).

3.4 Modelling

Models can be used to assess the consequences of different policy interventions in NFF-based scenarios. Models can range from qualitative descriptions of causality between states of different components of a social-ecological system, to quantitative models based on statistical or correlative relationships between variables or indicators in the social-ecological system, and to mechanistic models that can simulate complex social-ecological dynamics through mathematical equations or agent-based modelling (IPBES, 2016a). Standard quantitative modelling approaches also include measurement of uncertainties, or probabilities of achieving different outcomes, and are a necessary part of any NFF-based quantitative scenarios.

Depending on the time and spatial scales of scenarios, different models may be used to develop NFF-based scenarios. For short-term to medium-term projections (years to one decade) and at landscape to regional scales, it may be interesting to explore how different management regimes may lead to different outcomes for nature and nature's contributions to people (Box 2 in section 4.2). For instance, one could explore three management regimes for a landscape, across the three corners of the NFF (or any other points in the NFF) and compare them with the current management regime. A map of current land-use could therefore be modified in consultation with managers and other key stakeholders, to allocate more areas of the landscape to strict nature protection ('nature for nature'), or nature-based solutions ('nature for society'), or cultural landscapes ('nature as culture'). Different levels of ambition for each of the NFF-based scenarios could also be explored, for instance by allocating increasing proportions of the landscape to one of the management regimes. Then biodiversity models that project species' responses to land-use change could be used to project biodiversity, while ecosystem service models that project ecosystem services delivered by different biophysical elements could be used to project nature's contributions to people (for a list of models, see Kim et al., 2018; and for examples of scenario development at local and global scales, see Nelson et al., 2009 and Chaplin-Kramer et al., 2019). This approach allows users of the framework to explore the specific features associated with each NFF-based scenario. It can also be used to explore the relationship between different distributions of biodiversity features in a landscape and the resulting nature's contributions to people (Rieb et al., 2017).

Long-term scenarios, involving multi-decadal time scales, and often carried out at global scales, require that the trajectories of the direct drivers (e.g., land-use and harvest regime) themselves are modelled by examining the dynamics and the policy options for indirect drivers (e.g., population growth and life-style). Dynamics of indirect drivers have been explored for instance in the Shared Socioeconomic Pathways (SSPs) (van Vuuren et al., 2017) and have been analysed with Integrated Assessment Models (IPBES, 2016a). NFF-based scenarios associated with specific features can be combined with different Shared Socioeconomic Pathways (SSPs) and an assessment of the common features of indirect drivers required to achieve different NFF-based scenarios and levels of ambition. In some way, this approach is similar to the combination of Shared Socioeconomic Pathways (SSPs) and Relative Concentration Pathways (RCPs) (Riahi et al., 2017) to explore climate change scenarios. However, the common features associated with indirect drivers required to meet a given level of ambition for a NFF-based scenario may require the modification of the Shared Socioeconomic

Pathways to create Shared Socio-Ecological Pathways (see Box 3 in section 4.2). For instance, it may be that only certain demographic and lifestyle trajectories are consistent with specific NFF-based interventions on direct drivers that lead to positive trajectories for biodiversity or nature's contributions to people. Finally, long-term scenarios can also be used to close social-ecological feedback loops, at the local or global scale. This is important because coupled social-ecological dynamics may lead to the reinforcement of regime shifts (Figueiredo & Pereira, 2011; Scheffer, 2009). Here, NFF-based scenarios can be used to examine how policy interventions that lead to changes in nature's contributions to people may result in feedbacks, and for instance reinforce the effect of those policy interventions (for example in an urban context, see Mansur et al., 2022).

Quantitative modelling does not replace other qualitative tools that can be used in the development of NFF-based scenarios (e.g., participatory tools, local and expert knowledge), and they should be used complementarily. Initial narratives produced with qualitative tools may need to be refined in response to results from models, while models themselves may need to be refined to best capture key dynamics or priorities informed by local and expert knowledge. This can result in an iterative cycle of scenario development (Dietze et al., 2018) where narratives are refined with modelling results until a consistent set of narratives is produced.

Through stakeholder and expert workshops and consultations, the former IPBES expert group and current task force on scenarios and models are developing modelling approaches for NFF-based scenarios to support policy processes, which will be presented in a forthcoming paper (Kim et al., 2021 in preprint, PBL, 2019a; PBL, 2019b).

IV. Qualitative and quantitative applications of the NFF, particularly to support IPBES assessments

4.1 Applications of the NFF

The elements of the NFF methodological guidance (common and specific features, illustrative narratives, indicators and modelling approach) described in the previous section constitute a set of tools that offers guidance for the development and analysis of NFF-based scenarios. The NFF is designed to be sufficiently flexible to be applied to many contexts, and does not restrict the number of future scenarios. It allows users to develop scenarios in a creative and relevant manner applicable to their context, applying elements of the methodological guidance, as needed. As such, the NFF may be used for the exploration of the impacts of alternative development trajectories (exploratory approach), identification of plausible pathways toward desirable futures (target-seeking approach), and evaluation of the effectiveness of alternative policy, management and transformative options (policy-screening approach) (IPBES, 2016b). By catalysing the development of scenarios based on positive perspectives on nature in diverse contexts and across scales, NFF-based scenario applications give substance to, and illuminate possibilities for achieving the 2050 Vision for Biodiversity of 'Living in harmony with nature', where '*biodiversity is valued, conserved, restored and wisely used, maintaining ecosystem services, sustaining a healthy planet and delivering benefits essential for all people*' (CBD, 2010), and give support to the implementation of the post-2020 global biodiversity framework (see Box 2).

By generating scenarios based on positive perspectives on nature, the NFF necessitates the identification of transformative policy options that can enable these futures. Transformative futures should recognize the need to address sustainability goals, such as the Sustainable Development Goals, across economic, social and environmental criteria, as well as the post-2020 biodiversity framework and the vision of 'living in harmony with nature by 2050' (CBD, 2010; CBD, 2021). Within the arena of biodiversity conservation, there are a number of proposals as to how to transform the current system for better outcomes for nature and people (Büscher et al., 2017). There are many approaches, and not all are compatible with each other, which can result in tensions when differences between competing approaches are emphasised; lack of consensus potentially undermines an ambitious collective effort. One example is the land-sparing versus land-sharing debate that offers two contrasting pathways for agricultural and urban development to enable better outcomes for local and global biodiversity (Loconto et al., 2020; Immovilli & Kok, 2020, Kok et al., 2020 in preprint). Rather than emphasising any particular proposal as optimal, the NFF can be used to explore different visions for nature futures, such as the Half-Earth proposal introduced by Wilson (2016) that gained significant traction (see Box 4), and the Global Deal for Nature, which targets 30% of Earth to be formally protected (Dinerstein et al., 2019). Similarly, major economic transformations such as degrowth (Otero et al., 2020; Hickel, 2020; Demaria et al., 2013; Demaria, et al., 2019), the notion of green growth (Georgeson et al., 2017) and the European Green deal[3] are important reconfigurations for

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[3] (https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en)

scenarios on transformative futures for nature. Also, the implications of technological development, such as the continued growth of information and communication technology, artificial intelligence, nanotechnology and gene editing, and innovations in nature-based solutions[4] all have important consequences for the kind of futures that may emerge and are thus important to consider within newly developed scenarios for nature. Not all of these potentially transformative interventions can be considered in every scenario or model, but it is critical that some key aspects are explored, conventional modelling approaches are challenged, and knowledge gaps are highlighted. Development and analysis of NFF-based scenarios provide important input to the upcoming IPBES transformative change assessment and nexus assessment.

Due to its agility, the NFF can be easily combined with existing scenario methods and frameworks. A straightforward way of using the NFF, and the focus of several of the early applications, is to generate visions in participatory settings (e.g., Boxes 6, 7 and 8). The NFF values perspectives are used to open up discussions on desired futures and plurality of values, for which other components of the methodological guidance are not necessary. Rather, existing futures methods like the Three Horizons framework, future wheels, the Mānoa mash-up approach, or arts-based methods may be used to create rich visions of the future and think through pathways and develop storylines (Sharpe et al., 2016; Pereira et al., 2018).

The components of the methodological guidance are useful when the NFF is combined with the widely used story-and-simulation approach, a combination of qualitative narrative development and modelling exercises to translate narratives into quantitative information, often utilised to inform integrated assessment models (MA, 2005; O'Neill et al., 2017; Harrison et al., 2019). Users developing NFF-based scenarios with integrated assessment models or similar frameworks might wish to take a more methodical approach by introducing common and specific features for drivers, and by trying to adjust other drivers and responses to achieve common and specific outcomes. It should be noted, however, that narratives and scenarios that have been developed using these methods often do not differ radically in their future outcomes for nature (Leadley et al., 2010; IPBES, 2019a, 2019b) — in part because they tend to be constrained by what is possible to simulate with available modelling tools. This is not necessarily an intrinsic feature of the story-and-simulation approach, but is an important constraint imposed by using most currently available quantitative scenarios and modelling tools. This inflexibility of current tools would partly be resolved when using the NFF, which supports the use of both qualitative and quantitative modelling approaches.

Many users will already have well developed scenario frameworks and section 4.2 presents a few examples of how other scenarios (e.g., SSP-based frameworks implemented with integrated assessment models - see Box 3) can be placed within the NFF to illustrate its flexibility. This is likely to be one of the fastest ways to produce new scenarios that test the key aspects of the NFF's methodological guidance (see Leclère et al., 2020, as an example). While these other frameworks may not have the full ability to account for the value perspectives embodied in the NFF (especially the 'nature as culture' perspective), the framework should still allow the exploration of compatibility between other scenario frameworks and the NFF. There are some efforts to address the limitations in existing scenarios and modelling tools (see Box 3 as an example), and some priority gaps for modelling the NFF are identified in section 5. Users are encouraged to focus on developing novel scenarios and modelling tools that can more fully test the implications of the NFF.

4.2 Illustrative application examples

The following boxes provide examples of how the NFF could be applied to quantify global goals (Box 2), for existing global scenarios (Box 3), for global qualitative scenarios (Box 4), at local level (Box 5), and for participatory narrative development (Boxes 6, 7 and 8).

BOX 2 - NFF, and the use of scenarios, models and indicators in informing the post-2020 global biodiversity framework

Spatially-explicit time-series indicators on nature and nature's contributions to people can inform the goals and track targets of policy frameworks and agendas such as the post-2020 global biodiversity framework (CBD, 2021), and allow for strategic policy planning and implementation using scenarios and models (Kim et al., in prep. a). Scientists in the Group on Earth Observations Biodiversity Observation Network (GEOBON) are applying the NFF and its modelling approaches

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[4] Actions to protect, sustainably manage, and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits (Cohen-Shacham et al., 2016).

retrospectively, evaluating the impact of protected areas on biodiversity, ecosystems and nature's contributions to people. As an example, the study assigns protected areas with an objective of strict protection (IUCN categories I to III) as valuing primarily intrinsic values of nature ('nature for nature'), protected areas with human access for recreational benefits and sustainable use (IUCN categories IV and VI) as representing instrumental values of nature ('nature for society'), and protected areas of cultural landscape (IUCN category V) and indigenous land (Garnett et al., 2018) as co-created and co-inhabited space representing cultural values of nature ('nature as culture'). This study maps different categories of protected areas reflecting different value perspectives to evaluate how value-reflected decisions could impact nature and people, as well as to explore where synergies exist between different value perspectives (Kim et al., 2021 in preprint).

The analysis uses a suite of essential variables on biodiversity (area of habitat for species), ecosystems (area of natural and semi-natural ecosystems), and nature's contributions to people (pollinated crops, nitrogen retention, and coastal risk reduction) to quantify benefits to people near protected areas. The indicators derived from these variables can inform the estimated impact of Target 3, Goal A and Goal B of the post-2020 global biodiversity framework (GBF) by quantifying projected benefits from the expansion of area of natural ecosystems on the reduction of threatened species, and on the valuing, maintaining or enhancing of nature's contributions to people (CBD, 2021, Kim et al., in prep. a). This retrospective analysis utilises selected essential variables as indicators generated from the models of nature and nature's contributions to people, which have been used previously in BES-SIM model intercomparisons on the impact of Representative Concentration Pathways (RCPs) and Shared Socioeconomic Pathways (SSPs) climate scenarios that informed the IPBES Global Assessment (Rosa et al., 2020).

This is an illustrative and integrative application of multiple global frameworks – NFF, post-2020 global biodiversity framework, Essential Variables frameworks on biodiversity and ecosystem services – with the use of multi-faceted indicators to see how decisions on land protection and management have affected nature and people over time. Similar analyses can be conducted for protected areas, as well as for other targets (e.g., climate mitigation, pollution control) and components of goals (e.g., ecosystem disturbance, soil erosion control) of the post-2020 global biodiversity framework to continually assess and monitor their impacts on diverse values of nature and its contributions to people (see Figure Box 2). This study illustrates how the NFF can be used in developing scenarios to inform future decisions on policies by evaluating the potential consequences of different interventions that have been assessed on diverse values of nature.
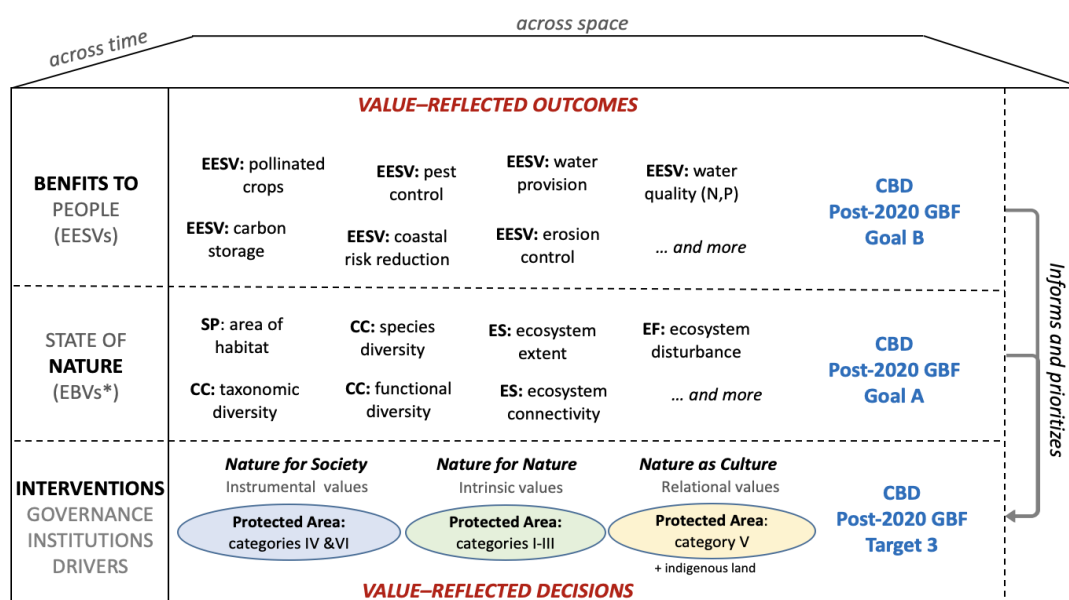
*SP: Species population, CC: Community composition, ES: Ecosystem structure, EF: Ecosystem functions   Source: Kim et al. in prep.

Figure Box 2. The NFF and simplified IPBES conceptual framework applied on Essential Biodiversity Variables (EBV)-based and Essential Ecosystem Services Variables (EESV)-based data analyses to inform the post-2020 global biodiversity framework. The value perspectives for nature are mapped to different categories of protected areas (GBF Target 3) as interventions for impact assessment. The "State of Nature" is assessed using the essential variables on biodiversity and ecosystems (GBF Goal A), and "Benefits to People" using the essential variables on nature's contributions to people (GBF Goal B). Such impact assessments can evaluate the consequences of value-reflected decisions on land and ocean protection and management on nature and people retrospectively and inform future decisions.

BOX 3 – **Implementing the NFF in existing global scenarios used by the IPCC and IPBES: The case of Shared Socioeconomic Pathways**

Shared Socioeconomic Pathways (SSPs) are scenarios of projected socioeconomic developments to 2100, incorporating human population trends, economic growth, urbanisation, etc. They are used together with the Representative Concentration Pathways (RCPs) of greenhouse gas emissions scenarios to explore a wide range of interlinkages between climate change and development pathways (Popp et al., 2017). The SSPs include SSP1 Sustainability (Taking the Green Road, see van Vuuren et al., 2017); SSP2: Middle of the Road; SSP3: Regional Rivalry (A Rocky Road); SSP4: Inequality (A Road divided), and SSP5: Fossil-fuelled Development (Taking the Highway; see Riahi et al., 2017). NFF-based scenarios could be regarded as being in line with SSP1. However, the SSP scenarios exclude elements (e.g., biodiversity) that interact with climate change except for SSP1, which focuses on environmental sustainability (O'Neill et al., 2014). Therefore, SSPs allow for the assessment of the impacts of climate change on biodiversity but generally do not account for biodiversity in the development pathways, nor the feedbacks between biodiversity and climate. In this regard, the NFF complements the SSPs (with a slight overlap in SSP1) by using value perspectives on biodiversity, and thus also filling gaps of the SSPs in how biodiversity is incorporated.

The SSP scenarios have been widely used in impact models that derive indicators of nature and nature's contributions to people. For example, the first global model intercomparison of biodiversity and ecosystem services that was catalysed by the IPBES expert group on scenarios and models in support of the IPBES Global Assessment was based on the SSP scenarios. Through this Biodiversity and Ecosystem Services Scenarios-based Intercomparison of Models (BES-SIM) exercise, a number of limitations were identified in using the SSPs that need to be taken into account in nature futures scenarios (Pereira et al., 2020; Rosa et al., 2020). For example, only SSP1 scenarios represent a sustainable socio-economic development pathway from the perspective of climate change, but include large scale land use conversion as part of climate mitigation strategies, which could be detrimental to biodiversity. To address this, it is suggested to incorporate diverse interventions on direct and indirect drivers and multiple roles and benefits of nature and nature's contributions to people into the socio-ecological modelling of nature futures scenarios (Kim et al., 2021 in preprint).

The NFF aspires to overcome the limitations of SSP scenarios through more integrative analysis across a broader range of drivers, sectors and policies by exploring and modelling the future of human and natural systems in relation to the three value perspectives for nature. The SSP framework is currently being applied in the marine environment to assess the future of the fisheries sector (Cheung et al., 2019; Cheung & Oyinlola, 2019; Maury et al., 2017) by attributing one or multiple NFF value perspectives to the SSP scenarios and expanding the range of drivers, sectors, and policies. Modelling approaches could range from heuristic to dynamically-coupled integrated models (Cheung & Oyinlola, 2019).

Along these lines, a collaborative consortium project including experts working with integrated assessment models, the SHAPE project (http://shape-project.org/), has put in place a process to create a new generation of target-seeking global scenarios called the Sustainable Developing Pathways (SDPs) using the NFF to capture multiple value perspectives in relation to nature. The SDPs aim at simultaneously achieving the Sustainable Development Goals in 2030 and the climate targets set out in the Paris Agreement. The new narratives (Krieger et al., in prep.) depart from SSP1 to represent alternative pathways for sustainable futures (Aguiar et al., 2020).

BOX 4 – Implementing the 'Half Earth' and 'Whole Earth' visions using the NFF

Two contrasting visions of nature and its relationships with people — 'Half Earth' and 'Whole Earth' — have emerged over the last several years and gained significant traction in discussions about the future of biodiversity and international objectives for biodiversity.

Proponents of 'Half Earth' advocate designating at least 50% of terrestrial and marine ecosystems as protected areas, with stringent limitations on human activities within these protected areas (Wilson, 2016; www.half-earthproject.org). This vision is based on the notion that setting aside half the Earth for nature is essential for avoiding extinctions across a wide range of species and that the intrinsic value for nature should motivate people to do so. Proponents of the 'Whole Earth' vision advocate "to rethink and nurture already existing and freshly emerging alternative conservation movements that are more democratic, equitable and humane." These movements see people as part of nature rather than separate from it and seek healthy environments across the Whole Earth. (Büscher et al., 2017).

Some key questions that can be addressed using NFF-based scenarios to explore these visions are: is it possible to halt and reverse biodiversity loss in plausible scenarios based on these visions, and are these scenarios equally effective in doing so? Is it possible to attain desirable levels of nature's contributions to people and good quality of life in both visions, and what are the risks involved for nature's contributions to people and good quality of life (Büscher et al., 2017; Kopnina et al., 2018; Ellis & Mehrabi, 2019; Schleicher et al., 2019)? These two visions put considerable emphasis on transformative changes in the use of land and sea: What additional transformative changes are necessary to achieve outcomes compatible with the NFF (e.g., eliminating reliance on fossil fuels)? These narratives have also been elaborated in Immovilli & Kok, (2019) and in Barrios et al., (2020), and quantitatively analysed for nature objectives, while also meeting climate and food security objectives in Kok et al. (2020 in preprint).

One means of implementing these visions would be to use the illustrative narratives developed by the IPBES task force on scenarios and models (Duran et al., in review). Half Earth is most closely aligned with the 'nature for nature' value perspective. The 'Arcology' narrative is an extreme version of setting aside a very large fraction of the Earth for nature and concentrating people in urban areas. Likewise, the Whole Earth vision corresponds to an intermediate position between the 'nature as culture' and 'nature for society' value perspectives (similar to the 'Innovative Commons' narrative presented in Box 1). In both cases, these illustrative narratives could then be converted to qualitative or quantitative scenarios using the methodological guidance of the NFF. Related frameworks and scenarios (e.g., Tallis et al., 2018; Obura et al., 2021) could also be leveraged.

A second means of implementing these visions could be to use the NFF values perspectives and common and specific features to modify existing scenarios (e.g., 'bending the curve' scenarios, Leclère et al., 2020). For the Half Earth vision, this would imply identifying the half of the Earth that should be protected based primarily on biodiversity considerations (e.g., Dinerstein et al., 2019; www.natureneedshalf.org), excluding most human activities such as agriculture, logging and fishing from these areas and then evaluating the impacts on biodiversity and nature's contributions to people. In this case, important biodiversity indicators might include species extinctions because of the strong value placed on avoiding extinctions in the Half Earth vision, as well as the biodiversity intactness index to evaluate the resulting 'naturalness' of ecosystems.

For the Whole Earth vision, the primary focus could be on the sustainable use of nature, with conservation areas being only one of several mechanisms for halting and reversing biodiversity loss; others might include sustainable fisheries, farming and forestry practices, sustainable consumption and land tenure that supports management by indigenous peoples and local communities. A mix of specific features for the 'nature as culture' and 'nature for society' perspectives (e.g., culturally important species, and species and genotypes that support provisioning services, respectively) could be used to develop a more complete scenario. Indicators of positive outcomes for nature could include conservation status of wild, domesticated and culturally important species and a wide range of nature's contributions to people.

Scenarios for both visions would also include common features such as strong climate change adaptation and mitigation with sustainable use of bioenergy, restoration of degraded habitats, and substantial improvements in the sustainability of production and consumption (Leclère et al., 2020).

BOX 5 - Indigenous peoples and the NFF

The NFF was developed with close involvement by indigenous peoples and local communities (IPLC) from the beginning. Its inclusion of relational values of nature as one of the three value perspectives was a result of strong IPLC participation in the first stakeholder workshop in 2017 where seven positive nature future visions were developed – visions which the task force later used to derive the NFF. Indigenous participants in this workshop decided to form one thematic group and developed a vision that strongly reflected relational values of nature. Their vision featured a world where "human-nature relations are based on reciprocity, harmony and relationality supported by educational systems infused by these values", where "food is predominantly produced in bio-culturally diverse and autonomous local food systems" and where "strong cultural institutions ensure respectful sharing among diverse knowledge systems and governance systems share universal recognition of local small producers and indigenous peoples' sovereignty over territories, resources and knowledge" (Lundquist et al., 2017).

The task force found in its subsequent stakeholder interactions strong receptivity from a range of stakeholders beyond indigenous communities for the 'nature as culture' perspective that encapsulates relational values in the NFF (PBL, 2019a; PBL, 2020; Pereira et al., 2020). Such broad support

illustrates the value of indigenous and local knowledge for the broader work of IPBES and nature conservation. Much work remains, with one significant challenge being the operationalisation of the nature as culture value perspective as it is almost entirely absent in existing global nature-related indicators, scenarios and models.[5]

Involving IPLC in the subsequent work to operationalise relational values in the NFF is paramount and the task force on scenarios and models is actively seeking such collaboration, for example through regular dialogue with the IPBES task force on indigenous and local knowledge. In 2021 the two task forces jointly organised an online workshop on scenarios and the NFF and indigenous and local knowledge holders were invited to participate. The dialogues ran over four days with regional sessions and a final plenary session. The workshop objectives were to engage IPLCs in reviewing the draft NFF and its methodological guidance and to work with IPLCs to start building regional-scale scenarios of futures, both as a capacity building exercise for IPLCs to develop scenarios in their communities, and to inform future IPBES assessments and work on scenarios and models.

Participants' feedback included appreciation for being able to see 'people's contribution to nature' in the nature as culture perspective and the potential of the NFF to create a dialogue across value systems and a helpful awareness-raising tool also for IPLCs. Key messages from participants were that: IPLCs cannot create future pathways without also considering past and present; future projections are essential to try to understand the complexity of the universe without placing the human being at the centre of it; indigenous conceptions of time can be more in the forms of cycles rather than linear trajectory; and that many science-based scenarios and models are looking for endings while indigenous peoples are looking for a guarantee that nothing will change.[6] It was also mentioned that while IPLCs envision their own futures, it is important for them to know the visions of scientists and engage in co-production of scenarios. Such co-production, however, may require new methods, and the IPLC perceptions of time and human-nature relations discussed should be central in such work.[7]

Following up on this dialogue workshop, the two task forces are planning another joint dialogue workshop on ILK and scenarios in September 2022 (to be confirmed) aimed at further discussing indigenous and local knowledge and scenarios, including how to address IPLC scenarios in on-going and future IPBES assessments.

Figure Box 5. Representation of the Asia-Pacific session of the workshop, created by Anjali Choudhary (IPBES, 2021).

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[5] The task force has noticed this gap in its interactions with the scientific modelling community and in its analysis of existing indicators. For an exception, see Schröter et al., 2020. Global indigenous visions and scenarios can, however, be found in the Local Biodiversity Outlook 2 (Forest Peoples Programme, International Indigenous Forum on Biodiversity, Indigenous Women's Biodiversity Network, Centres of Distinction on Indigenous and Local Knowledge and Secretariat of the Convention on Biological Diversity (2020)) and there are many documented local examples of indicator development in indigenous communities, see e.g., Sterling et al., (2017). There are also efforts emerging among modellers working with the NFF that include the nature as culture perspective (Pereira et al., 2013).

[6] An example of current analysis of the future from indigenous Mayan communities from Mexico: https://www.frontiersin.org/articles/10.3389/fsufs.2021.618453/full

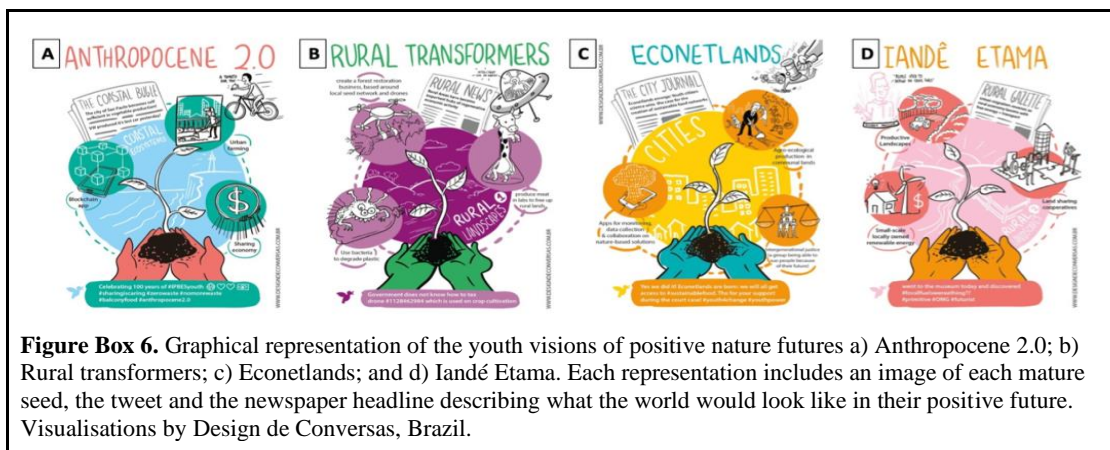[7] For a detailed description of the workshop see IPBES, (2021).

BOX 6 - Nature futures youth workshop (organized by the IPBES task force on capacity building - based on paper by Rana et al., 2020)

Engaging young people is critical in shaping societies' futures and can help to elevate factors that youth consider pivotal and significant. However, younger generations remain insufficiently integrated into science-policy and decision-making arenas regarding their future, which is tightly linked to the future of the planet (Lim et al., 2017). In order to start addressing this gap, and to increase the diversity of stakeholders and disciplines that had been engaged in the NFF, an NFF visioning exercise was organised as part of a youth workshop that took place in São Pedro, Brazil from 27 June to 28 June 2019. The workshop was organised by the IPBES task force and technical support unit for capacity-building, in collaboration with the former expert group on scenarios and models, amongst others, and was facilitated by IPBES experts and fellows of the Global Assessment and the Americas and Europe and Central Asia Regional Assessments of Biodiversity and Ecosystem Services (IPBES, 2019b).

The facilitators used the NFF as a starting point for the visioning exercise. First, a triangle was drawn on the floor to represent the NFF with the three different values of nature: 'nature for nature', 'nature for society' and 'nature as culture'. Participants were asked to reflect on 'why they value nature', thinking of a particular context and situation, and, based on this, position themselves within the triangle. They then paired up in groups of two, with their closest neighbours in the triangle, to discuss their respective examples and associated values of nature. Subsequently, the pairs merged into groups of four, and so on for further rounds of discussion. This process had two aims: (1) to familiarise the participants with the NFF and to facilitate thinking about diverse values of nature and how these fit in a desirable future vision; and (2) to divide them into groups for the visioning exercise without pre-allocating them. The method increases the likelihood of affinity between group members in terms of how they perceive nature. By ensuring that the full space of the NFF had been covered by the four groups, it was hoped that the resulting visions would showcase diverse appreciation of values of nature across groups, even if this was not made explicit in the instructions. Groups were then allocated a theme (cities, rural landscapes or coastal landscapes) to focus their discussions on. They developed their visions, starting with an identification of 'seeds' or initiatives that they hoped would shape a more desirable future for people and nature, then answering a set of questions of what this future could look like and concluding with a presentation of these visions to the whole group (adapted Manoa mashup-method from Pereira et al., 2018).

The groups used the NFF to develop visions of the future that had some similarities, but also differences (Figure Box 6). For example, the Econetlands vision - with participants from the 'nature as culture' region of the NFF - prominently captured aspects of traditional knowledge and indigenous ways of knowing; the Rural Transformers - with participants from the 'nature for society' region of the NFF - included themes that highlighted instrumental values, where people value and conserve nature for a sustained flow of ecosystem services; and Iandé Etama - with participants from the 'nature for nature' region of the NFF - explicitly included aspects of protected areas, which are often established to conserve biodiversity for its intrinsic value. An interesting commonality across the groups was the discussion of the need for alternative economies and new metrics that recognise well-being and happiness, moving beyond simply economic growth, and proposing a post-monetary economy.

The visioning exercise was framed around the NFF and set up around three seeds, but also designed to work within a timeframe of 1.5 days. While the methodological approach allowed for more focussed, in-depth discussions on certain aspects of the positive futures, there was insufficient time to capture tensions and feedbacks between different NFF value perspectives. Further, while this exercise was not meant to represent all the diverse voices of the global youth, it can serve as a starting point for similar initiatives to take place, possibly led by the participants themselves in their communities. There is learning from this workshop on how to invest in participatory processes that tap into the vast potential of young people, including researchers. The process in this workshop was unique in that it was completely youth-led. Although it seems that there has been little space for the voices of the youth to be clearly articulated in intergovernmental processes, initiatives like these, using the NFF, are able to take a small step forward in galvanising a more youth-oriented discussion of better futures.

Figure Box 6. Graphical representation of the youth visions of positive nature futures a) Anthropocene 2.0; b) Rural transformers; c) Econetlands; and d) Iandé Etama. Each representation includes an image of each mature seed, the tweet and the newspaper headline describing what the world would look like in their positive future. Visualisations by Design de Conversas, Brazil.

BOX 7 - Use of the NFF for the High Seas

The remoteness and vastness of the open ocean has inadvertently created a psychological and perhaps even cultural barrier between most cultures and the global ocean. Four decades after the UN Convention on the Law of the Sea (UNCLOS) was ratified, the governance landscape for the management of human activities and their impacts in the high seas remains fragmented, sectoral in nature and largely failing to achieve their sustainability mandates. To address the looming gap hindering the adoption of a transformative framework that places human-nature relationships at the centre of the discussion, a visioning exercise with some key experts on the high seas was undertaken using the NFF. The aim of this was to start invigorating a more robust debate on transformative change for more desirable futures for the high seas, which takes multiple values into account and allows for nature and people to thrive.

During the course of 2021, three online workshops (of two sessions each due to time zones) were held with 29 participants from diverse backgrounds, ages and geographies, totalling 21 hours of engagement. This expert-driven visioning exercise relied on the exploration of diverse and rich dialogues between key stakeholders in the ocean system, with the high seas being the focus. The three workshops were designed around an adapted Three Horizons framework (Sharpe et al., 2016), and aimed at unpacking Horizon 1 in the first instance, Horizon 3 in the second, and Horizon 2 in the third and final online workshop. The NFF was the main focus of the second workshop, i.e., the creative visioning of a more desirable, transformed future for the high seas. A pilot workshop to test the method was also run, resulting in 7 final visions. The method bridged a 'seeds' approach with science-fiction prototyping: participants had been asked to fill in a questionnaire beforehand outlining a process, initiative or way of seeing the world that was currently marginal, but that they thought could contribute to a better future for the high seas. After sharing this 'seed' idea, participants were placed into groups based on where in the NFF their seed initiative most resonated and then tasked to envision a future that builds on these seeds, then developing a short science-fiction narrative to help describe what this world looked like. In order to push the participants to think about a much more radical future, seven characters were developed, each with a bit more of an affinity to a particular corner. Each group rolled a dice to see which of the characters they would encounter in their story, and take into account in the development of the narratives.

The stories are outlined in the workshop 2 report (Chibwe et al., 2021), but to give a flavour of what resulted, the names of the groups offer an indication of their core components (Table Box 7). Artwork was also commissioned to give a visual sense of what futures were emerging from the discussions (Figure Box 7).

Table Box 7. Scenario names for the High Seas future visions.

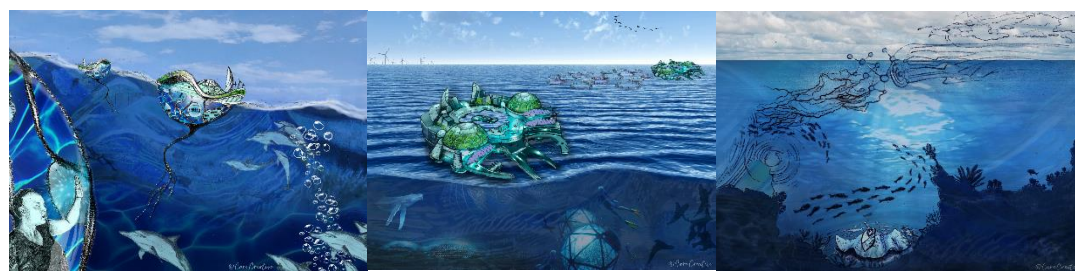| Nature as culture	Nature for nature	Nature for society
Pheno-Asherah – polycultural fractals of beings with the ocean	Globaia Oecosystema Panopticana	One Blue Station
All Ocean Voices	Rights among the sentient stewards of the sea	Mare Communum- Slow Ocean
Deep Peace of the Ocean- Ocean Harmony		

Figure Box 7. Graphical representations of High Seas futures: left) nature for nature, center) nature as culture, right) nature for society ©CareCreative

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BOX 8 -- Using the NFF to facilitate a local participatory visioning process in National Park Hollandse Duinen

National Park Hollandse Duinen in the Netherlands is being developed in one of the most densely populated regions of Europe. It aims to showcase how humans and nature can coexist. The surface area of the park is ~450 km^2 and covers the entire coastline of the province of Zuid Holland, including sea, beaches, dunes and forests, but also agriculture, infrastructure and cities. The development of the national park was catalysed by the local community. A diverse group of local stakeholders recognised that, in the face of Anthropocene pressures, the preservation of high biodiversity values in this unique landscape requires an integrated and collective effort and started exploring new ways of interacting with each other and with nature.

In 2019, the NFF was applied to structure a participatory visioning process to inform the bottom-up development of National Park Hollandse Duinen (Kuiper et al., 2021 in preprint). The process, collaboratively designed by researchers and key stakeholders, combined the NFF with the Three Horizons framework, a foresight tool for collaborative exploration of transformative change (Sharpe et al., 2016), and the Sustainable Development Goals. The purpose was to envision desirable futures for the national park, explore transformational pathways to get there, and assess the potential contribution to the Agenda 2030. The NFF was specifically used as a tool to help stakeholders identify and articulate their own desired relationship with nature, understand the diversity and plurality of people's perspectives on nature, and identify shared values as fertile grounds for developing rich, pluralistic visions in which multiple values of nature are enhanced.
The 'nature as culture' perspective was appreciated because it extended existing discussions among the participants on the dichotomy between intrinsic and instrumental values, opening-up to a broader appreciation of nature based on which new partnerships between stakeholders could be explored. The visions that emerged facilitated a discussion of trade-offs and opportunities for synergies in the area of the National Park. Through the participants, these discussions fed into the development of a landscape strategy document that was presented in 2020, which in turn paved the way for the first implementation program 2021-2025. Both documents (in Dutch) can be retrieved from the website of National Park Hollandse Duinen (www.nationaalparkhollandseduinen.nl).

V. Knowledge gaps and priorities to enable use of the NFF

An increased availability of NFF-based scenarios, which offer positive visions of the future for nature for a variety of locations and scales, will help IPBES experts to better respond to overarching questions in future IPBES assessments. NFF-based scenarios, and the participatory processes involved in their development, will, in turn, facilitate policymaking by governments globally and nationally, and decision-making by other stakeholders. Ongoing efforts to apply the NFF to scenario development, and ultimately to policy making, will help catalyse further refinement of the NFF's methodological guidance and associated modelling tools, and the identification of new pathways toward sustainable futures. Users of the NFF, including the modelling community and other stakeholders, may be interested in filling some of the knowledge gaps identified in this section by the IPBES task force on scenarios and models. Key topics identified by the task force include: 1) developing additional illustrative narratives as examples to showcase the plurality of scenario narratives that can be created using the NFF; 2) identifying and using indicators for the NFF that can be associated with different value perspectives; 3) addressing knowledge gaps in social-ecological feedbacks; and 4) advancing current modelling frameworks to facilitate the application of the NFF.

The task force is not mandated to undertake these activities itself. Rather it aims to catalyse them. Capacity building efforts are part of that catalysation process, and together with the IPBES task force

on capacity building, the task force on scenarios and models will consider different methods, such as webinars, downloadable content on the NFF and NFF-based scenarios tailored to different audiences. These priorities are envisioned as necessary elements to enhance the use of the NFF in supporting ongoing IPBES assessments, however other priorities may emerge during the ongoing development and utilisation of NFF-based scenarios by governments and the scientific community.

5.1 Illustrative narratives

The process of creating illustrative narratives using the NFF highlighted one of many possible methods for operationalising the framework (Duran et al., in review; PBL, 2020) that could be expanded to apply the NFF to diverse sociocultural and geographical contexts. Areas for future engagement and illustrative narrative development include:

1. Use NFF-based scenarios to engage diverse communities to explore and identify transformative interventions and sustainability solutions. A given storyline might be consistent with a range of potentially transformative options, such as different economic concepts like post-degrowth, circular economy and decoupling as well as different knowledge systems and ways of thinking about human-nature relations. These options can be harnessed to inform the development of storylines that represent these potentially transformative options. At the same time, it also unpacks existing framings, such as continued, but 'green' growth, what would be required to enable this development pathway and the future that might emerge. This enables further exploration of possible actions and pathways to achieve transformative change as presented in Table SPM.1 of the IPBES Global Assessment (IPBES, 2019a). The emphasis on creative engagement that leverages the imagination is increasingly recognised as an important capacity to mobilise in the global assessment community and more can be done to enable the uptake of these critical engagements with multiple futures;

2. Unpack the different values ascribed to nature and nature's contributions to people within the NFF. A strength of the NFF is that it accommodates a multitude of different value perspectives but delineating what falls outside the framework's triangle and ensuring consistency among NFF-based scenarios is challenging, as existing scenario approaches often focus on drivers and consequences that are outside of that triangle. It is important to realise that the inside of the triangle is relative to the three corners and that relativity (of goals, targets, and mechanisms for change) needs to be maintained, and that the framework can be used to identify both synergies and trade-offs between different value perspectives;

3. Appreciate and engage with the diverse range of values of nature and visions of the future as highlighted by the IPBES values assessment. While the aim of the NFF is to allow for a plurality of perspectives to emerge, these are ultimately narrowed down as soon as scenarios are created. It is important to recognise that the illustrative narratives do not imply a singular, restrictive story to capture a particular perspective. Encouraging variations to the stories created by different groups in different spaces is one way to address this.

5.2 Identifying and using indicators for the NFF

The NFF requires identification and development of additional indicators that can be associated with the different value perspectives to help further develop its methodological guidance (see also section 3.3). Indicators are valuable for communicating the potential success of different scenarios at achieving biodiversity or sustainability goals and should be able to capture both positive and negative outcomes across the three value perspectives. Reviews of existing global indicator sets led by the task force on scenarios and models included the core and highlighted indicators that were recommended for use in the IPBES Global and Regional Assessments and other policy relevant indicator sets[8], as well as the indicators conceptualised for nature futures using the essential biodiversity variables (EBV) through the EBV2020 Initiative by the Group on Earth Observations Biodiversity Observation Network (Kim et al., in prep. a). Many of these indicators are based on global and regional datasets that could contribute to scenarios and models, as reviewed in Chapter 7 of the IPBES Scenarios and Models assessment (Lundquist et al., 2016). The reviews showed that the availability of indicators is not balanced across the three NFF value perspectives, with most of them illustrating specific features of the 'nature for society' and 'nature for nature' perspectives, and few available indicators for 'nature as culture'. For example, from 193 'ready to use' indicators from various global policy related indicator sets, only two indicators were categorised for specific features of the 'nature as culture' perspective (Karlsson-Vinkhuyzen et al., in prep). Noticing the gap in 'nature as culture' indicators,

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[8] e.g. indicators used under the Convention on Biological Diversity, Biodiversity Indicators Partnership and System of Environmental-Economic Accounting

efforts were made to identify possible indicators for this perspective from the sources developed by the indigenous and local knowledge community. These efforts included aligning indicators from the Indigenous Navigator and with specific transitions developed in the Local Biodiversity Outlook 2[9] (see Box 5). Furthermore, more than 40 indicators associated with the NFF value perspectives (existing and aspirational) were collated from the use of essential biodiversity and ecosystem services variables (EBVs, EESVs) for modelling NFF-based scenarios (Kim et al., in prep. b). The EBV- and EESV-based indicators can be used or developed as common and specific indicators. Remote-sensing and *in-situ* data can be used in models to assess the status, trends, and dynamics of nature and nature's contributions to people. The gaps identified in these lists imply similar gaps in the indicators (representing each value perspective) that have been used in existing models and scenarios.

The task force on scenarios and models, while not having a mandate to develop indicators itself or to provide any list thereof, can encourage the scientific community to further develop indicators for NFF-based scenarios in doing the following:

1. Continue work on developing more detailed guidance for the process of identifying appropriate indicators for the three value perspectives, through illustrating potential example indicators;

2. Select some illustrative indicators for each illustrative NFF narrative, and work with the scientific community to define the baseline conditions and relevant context-specific data to inform the indicators, analyse their trends, and identify the models available to examine their dynamics from local to global levels; this initial indicator exercise could provide guidance and help to catalyse the scientific community to develop representative indicators for each illustrative NFF narrative;

3. Identify additional ready-to-use indicator sets relevant for NFF-based scenarios and models, particularly from other (non-biodiversity) sectors representing indirect and direct drivers, responses and other feedbacks;

4. Encourage modelling and indicators communities who work on biodiversity and ecosystem services to improve existing indicators by, for example, integrating the latest scientific advancement and data, and hence filling critical gaps;

5. Make considerable efforts, in close collaboration with the IPBES task force on indigenous and local knowledge, and the community of indigenous peoples and local communities, to catalyse the identification of existing indicators or development of new indicators that can illustrate relational values of nature ('nature as culture'), particularly at national to global scales.

6. Develop some methodological guidance for NFF users, including the modelling community, on approaches for developing new indicators for the different NFF value perspectives, including how to capture non-material aspects of culture.

7. Through impact evaluations and evidence synthesis, further develop evidence base describing effectiveness of a broad range of management actions (e.g., nature protection, indigenous management, sustainable management practices) regarding the most representative indicators for each illustrative NFF narrative;

8. Encourage the international community to work on closing the gaps in available indicators to allow measurement and monitoring of changes in nature, drivers and socioeconomic and ecological implications.

5.3 Social-ecological feedbacks

The IPBES Global Assessment identified 'improved understanding of social-ecological interactions and associated positive and negative feedbacks across space and time' as a key knowledge gap. These social-ecological feedbacks are rarely included in current scenarios frameworks, and include interactions in which social, economic, and ecological variables influence each other. For example, fishing changes the availability of fish, which changes fishing practices; this simplistic example illustrates links between 'nature for society' (fish as a resource), 'nature as culture' (cultural fishing practices that may be lost if fish are overharvested, or that may change if fish are no longer available), and 'nature for nature' (additional feedbacks in fish ecosystems through removal of predators and impacts on food webs). Feedback loops can be positive or negative and can result from natural phenomena or human-nature interactions that can amplify or dampen change. Different sets of feedbacks are integral aspects for the development of many new scenarios for nature, but there are

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[9]
https://www.google.com/url?q=http://indigenousnavigator.org&sa=D&source=docs&ust=1642579344929852&usg=AOvVaw2XLDLcz9Klc_m2wzYYJx-P

biases in our understanding of these different types of feedbacks, with better understanding of feedbacks related to the 'nature for society' perspective and limited knowledge of feedbacks related to the 'nature as culture' perspective.

Current knowledge gaps on social-ecological feedbacks that could be addressed by the scientific community and other relevant stakeholders to further inform the inclusion of social-ecological feedbacks within NFF-based scenarios and models include:

1. Identification of feedbacks that should be included, at minimum, in NFF-based scenarios, and guidance prepared as to how to include the complexity of feedbacks across the different value perspectives;

2. Exploration of feedbacks that are often missing from models, particularly feedbacks that are important for the 'nature for nature' and 'nature as culture' perspectives. More effort is needed to produce models that represent multiple types of feedbacks from these different value perspectives;

3. Creation of new, desirable scenarios for nature requires a multidisciplinary approach that includes identifying and understanding feedbacks from the point of view of different knowledge systems, and how feedbacks vary regionally depending on social or cultural traditions and practices;

4. Identification of mutually reinforcing feedbacks between values of nature that have potential to amplify synergies as win-win solutions;

5. Identification of key feedbacks for different places and systems (including methods for identifying them by stakeholders), which could be reflected in scenarios and modelling applications for informing decisions;

6. Development of guidance for modelling social-ecological feedbacks that act across scales, including how to integrate cross-scale and telecoupled dynamics into NFF-based scenarios.

5.4 Modelling

The NFF's multi-scale and multi-perspective approach and focus on dynamic interactions between humans and nature demands advancement from existing modelling frameworks. Such advancement and development would facilitate the application of the NFF to tackle key questions on nature, nature's contributions to people and quality of life, particularly in relation to the nexus between different global and local changes, telecoupling, and projections of transformative actions. Specific gaps include (see also Rosa et al., 2020 and IPBES, 2016a):

1. Developing integrated modelling that represents the dynamic interactions between social (including economic components) and ecological systems (as detailed in section 5.3);

2. Performing multi-scale modelling that accounts for diverse drivers and policy responses at multiple spatial, organisational and temporal scales (Carpenter et al., 2009);

3. Developing linkages between qualitative models and tools (e.g., Moon et al., 2019) and quantitative models;

4. Integrating use of local and traditional knowledge together with scientific knowledge in modelling (Tengö et al., 2014);

5. Integrating biodiversity time series monitoring into calibration of biodiversity models (Ferrier et al., 2017), to overcome current reliance on space for time distribution with static biodiversity data. Changes to collecting time series data and develop long-term monitoring also need to be addressed, particularly in regions with insufficient data;

6. Connecting biodiversity at species level, to ecosystems services, and ecosystem services to human demand for those services and their relative contribution to human wellbeing (Chaplin-Kramer et al., 2019);

7. Improving the ability to incorporate relational values and intangible values of nature in scenarios and models (Schröter et al., 2020);

8. Modelling the influence of societal barriers and challenges, entrenched interests and power dynamics in society;

9. Developing approaches to modelling that are inclusive, diverse and equitable and that leverage stakeholder engagement.

In combination, these knowledge gaps reflect the various aspects of the methodological guidance of the NFF that require further development.

VI. Concluding remarks

This document describes the NFF (Figure 2). The NFF captures the plurality of value perspectives on nature and helps users describe diverse desirable futures by placing human-nature relationship at its core. This new scenarios framework is a shift from traditional ways of projecting impacts of society on nature, to scenarios that focus on positive futures to support policy and decision making that reverse negative trends in nature and nature's contribution to people. To promote the development and use of new scenarios that incorporate the multiplicity of perspectives on nature, the document presents methodological guidance for using the NFF, starting with common and specific features. These features can help conceptualise and build scenarios at particular locations within the NFF. Next, as guidance for the process of developing narratives, examples are given as to how existing global scenarios could be translated to particular locations in the NFF, and how the NFF has been applied in diverse qualitative and quantitative contexts. Further, guidance is presented for identifying existing or new indicators for using the NFF. Finally, the methodological guidance discusses current developments in modelling the NFF, and application of both qualitative and quantitative modelling approaches. Knowledge gaps are identified that could be filled by the scientific modelling community and other stakeholders that, once addressed, will help operationalise the NFF and add to the methodological guidance.

The methodological guidance of the NFF is still evolving and should therefore be considered as a work in progress. As shown in Figure 1, the involvement of the task force is envisioned to gradually reduce as the task force catalyses further work on scenarios and models, and community interest and participation increases. Ultimately, the development of NFF-based scenarios across scales, in different regions of the world, and in different knowledge systems, will depend on adoption of the NFF by the scientific and practitioner communities (e.g., modelling, social sciences and humanities). The development of such new scenarios for nature needs to take into account various perspectives on people's relationships to nature and different stakeholder needs across scales. The use of the NFF by the scientific community, and other stakeholders will lead to the further development, identification and utilization of new qualitative and quantitative scenarios and model applications. This, in turn, can provide valuable input for future IPBES assessments and trigger the much-needed actions and societal transformations towards a desirable future for nature and people.

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Appendix II

Glossary of terms used in the NFF

Drivers (direct and indirect): In the context of IPBES, drivers of change are all the factors that, directly or indirectly, cause changes in nature, anthropogenic assets, nature's contributions to people and a good quality of life. Direct drivers of change can be both natural and anthropogenic. Direct drivers have direct physical (mechanical, chemical, noise, light etc.) and behaviour-affecting impacts on nature. They include, inter alia, climate change, pollution, different types of land use change, invasive alien species and zoonoses, and exploitation. Indirect drivers are drivers that operate diffusely by altering and influencing direct drivers, as well as other indirect drivers. They do not impact nature directly. Rather, they do it by affecting the level, direction or rate of direct drivers. (IPBES online glossary accessed 26 November 2021)

Good quality of life: Within the context of the IPBES conceptual framework – the achievement of a fulfilled human life, a notion which may vary strongly across different societies and groups within societies. It is a context-dependent state of individuals and human groups, comprising aspects such as access to food, water, energy and livelihood security, and also health, good social relationships and equity, security, cultural identity, and freedom of choice and action. 'Living in harmony with nature', 'living-well in balance and harmony with Mother Earth' and 'human well-being' are examples of different perspectives on a 'Good quality of life'. (IPBES online glossary accessed 26 November 2021)

Heuristic : A method of learning or solving problems that allows people to discover things themselves and learn from their own experiences (Cambridge Dictionary, 17.12.21)

Indicators: A quantitative or qualitative factor or variable that provides a simple, measurable and quantifiable characteristic or attribute responding in a known and communicable way to a changing environmental condition, to a changing ecological process or function, or to a changing element of biodiversity (IPBES online glossary accessed 13 May 2021; Kim et al., 2021 in preprint).

Intrinsic value: This concept refers to inherent value, that is the value something has independent of any human experience or evaluation. Such a value is viewed as an inherent property of the entity and not ascribed or generated by external valuing agents (Pascual et al., 2017).

Instrumental value: The value attributed to something as a means to achieving a particular end (Pascual et al., 2017).

Modelling community: Largely composed of biodiversity and ecosystem services modellers but it is envisaged that the community is broadened to other sectoral and disciplinary modelling, including social science and humanities, to best develop nature futures scenarios.

Models: Qualitative or quantitative representations of key components of a system and of relationships between the components (IPBES online glossary accessed 28 July 2020; Kim et al. 2021, in preprint).

Mother Earth: An expression used in a number of countries and regions to refer to the planet Earth and the entity that sustains all living things found in nature with which humans have an indivisible, interdependent physical and spiritual relationship (see 'nature') (IPBES online glossary accessed 19 January 2022).

Narratives (or scenario narratives): Qualitative descriptions which provide the framework from which quantitative exploratory scenarios can be formulated (Kim et al., 2021 in preprint).

Narrative family: The concept of Narrative Families has been developed to help people understand how narratives are related to diverse values, as well as the commonalities and differences between narratives. In particular, Narrative Families provide a structure for translating diverse values into more detailed descriptions of desirable futures (i.e., narratives) that can be easily understood by experts and non-experts alike. Narrative Families also provide a well-organised set of features that can be used by the scientific community and other stakeholders for developing qualitative or quantitative scenarios that are consistent with the NFF. They also offer a means of classifying NFF-based scenarios into

groups with similar assumptions to facilitate synthesis for IPBES assessments (IPBES/MEP-Bureau/15/11).

Nature: In the context of IPBES, refers to the natural world with an emphasis on its living components. Within the context of western science, it includes categories such as biodiversity, ecosystems (both structure and functioning), evolution, the biosphere, humankind's shared evolutionary heritage, and biocultural diversity. Within the context of other knowledge systems, it includes categories such as Mother Earth and systems of life, and it is often viewed as inextricably linked to humans, not as a separate entity (see 'Mother Earth') (IPBES online glossary accessed 19 January 2022).

Nature-based solutions: Actions to protect, sustainably manage, and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits (Cohen-Shacham et al., 2016).

Nature's contributions to people: Nature's contributions to people (NCP) are all the contributions, both positive and negative, of living nature (i.e., diversity of organisms, ecosystems, and their associated ecological and evolutionary processes) to the quality of life for people. Beneficial contributions from nature include such things as food provision, water purification, flood control, and artistic inspiration, whereas detrimental contributions include disease transmission and predation that damages people or their assets. Many NCP may be perceived as benefits or detriments depending on the cultural, temporal or spatial context. (IPBES online glossary accessed 26 November 2021)

Nature Futures: Future states of nature that 'represent a wide range of human–nature interactions, based on the perspectives of different stakeholders, and include a variety of different types of human-modified ecosystems encompassing different degrees of human intervention' (Rosa et al., 2017; Kim et al., 2021 in preprint).

Nature futures framework (NFF): A heuristic that captures diverse, positive values of human-nature relationships in a triangular space: Three types of value perspectives on nature in the NFF – intrinsic (also known as 'nature for nature'), instrumental ('nature for society'), and relational ('nature as culture') values. These values of nature are not mutually exclusive and intricately intertwined by nature (Pereira et al. 2020a; Lundquist et al., in preparation; Kim et al., 2021 in preprint).

Pathways: Different strategies for moving from the current situation towards a desired future vision or set of specified targets. They are purposive courses of actions that build on each other, from short-term to long-term actions into broader transformation (Ferguson, Frantzeskaki, & Brown, 2013; Wise et al., 2014). The Three Horizons approach is often used to define such pathways in future visioning processes (Sharpe et al., 2016, Pereira et al., 2020)

Relational value: The values that contribute to desirable relationships, such as those among people or societies, and between people and nature, as in 'Living in harmony with nature' (IPBES/4/INF/13). (IPBES online glossary accessed 26 November 2021)

Rewilding: Restore (an area of land) to its natural uncultivated state (used especially with reference to the reintroduction of species of wild animal that have been driven out or exterminated (Oxford Dictionary of English).

Scenarios: Representations of possible futures for one or more components of a system, particularly for drivers of change in nature and nature's benefits, including alternative policy or management options (IPBES online glossary accessed 28 July 2020; Kim et al., 2021).

Scenario family: Scenarios that have a similar demographic, societal, economic and technical change storyline (IPCC glossary: Glossary of terms on the IPCC-Data Distribution Centre)

Value: A principle or core belief underpinning rules and moral judgments. Values as principles vary from one culture to another and also between individuals and groups (IPBES/4/INF/13; Kim et al., 2021 in preprint).

Visions: A desirable state in the future and therefore, a component of scenarios (the possible future states), demarcated from predictions (likely future states) and pathways (that lead up to the vision). Visions are usually seen as a desirable image of the future and can be defined as a compelling,

inspiring statement of the preferred future that the authors and those who subscribe to the vision want to create (Wiek & Iwaniec, 2014; Pereira et al., 2020)

Visioning: "the process of creating a vision, i.e., a representation of a desirable future state, as opposed to scenario building (possible future states), forecasting (likely future states), and backcasting (pathways to desirable future states)". (Wiek & Iwaniec, 2014).

Appendix III

List of events related to the nature futures framework

Events organized by or with the involvement of the IPBES technical support unit for scenarios and models

1. Workshop 'Visions for nature and nature's contributions to people for the 21st century', Auckland, New Zealand, 4-8 September 2017

2. Booth and survey on the nature future visions outside of the Plenary at the 6th Plenary session of IPBES, Medellin, Colombia, 17-24 March 2018

3. Workshop 'Next steps in developing nature futures', the Hague, the Netherlands, 25-28 June 2018

4. IPBES scenarios and models for Nature Futures side event at CBD SBSTTA 22, Bonn, Germany, 3 July 2018

5. Nature Futures Day at the Rio Conventions Pavilion, CBD COP 14, Sharm El-Sheik, Egypt, 20 November 2018

6. Workshop 'From visions to scenarios for nature and nature's contributions to people for the 21st century', Vancouver, Canada, 25-27 March 2019.

7. Workshop 'Global modelling of biodiversity and ecosystem services', the Hague, the Netherlands, 24-26 June 2019

8. IPBES Youth workshop for young professionals and practitioners, São Pedro, Brazil, 27-28 June 2019

9. São Paulo School of Advanced Science on Scenarios and Modelling on Biodiversity and Ecosystem Services to Support Human Well-Being (SPSAS Scenarios), Sao Paulo, Brazil, 1-14 July 2019

10. Workshop 'New Narratives for Nature: operationalizing the IPBES Nature Futures Scenarios', Hayama, Japan, February 2020

11. Workshop on modelling Nature Futures scenarios under the 2030 IPBES rolling work programme, online, 12-15 January 2021

12. Science-policy dialogue workshop with national focal points in two sessions, online, 4 October 2021

13. Dialogue workshop with the wider scientific community, including experts on narrative approaches from the humanities and social science in three sessions, online, 6 October 2021

14. Dialogue workshop with experts on indigenous and local knowledge and representatives of indigenous peoples and local communities in three sessions, online, 28, 29 and 30 September 2021, and a plenary session on 19 October 2021

Other events

1. Presentations and symposium entitled 'IPBES Stakeholder Co-creation of Multiscale Scenarios for Nature Futures' at Natural Capital conference, Stanford University, California, USA, March 2018

2. Presentation on NFF at Society for Conservation Biology 5th Oceania Congress: Conservation in a changing world, Te Papa, Wellington, New Zealand, 3-5 July 2018

3. Presentation on NFF. Online invited webinar, National Ecological Assessments working group, UNEP-WCMC, 23 October 2018

4. Discussing the IPBES Nature Futures scenario results as tools for exploring policies that enhance the feasibility of visions, identifying pathways and ensuring sectoral and regional relevance of the visions at the Rio Conventions Pavilion Programme CBD COP14, Sharm El Sheikh, Egypt, 20 November 2018

5. Workshop to design NFF-based scenarios for China, "International Workshop on the Design of Biodiversity and Ecosystem Service Scenarios, Beijing, China, 20-23 January 2019

6. Presentations and exercises on the NFF to students and researchers in multiple locations in the Netherlands (Vrije Universiteit Amsterdam, Wageningen University & Research, Utrecht), 2019

7. Presentation on the NFF at the Forum on Scenarios of Climate and Societal Futures, University of Denver, USA, 11-13 March, 2019

8. Presentation on the NFF the BioDivERsa kick-off meeting and stakeholder workshop, Helsinki, Finland, 14-16 May 2019

9. Presentation on the NFF at the ALTER-Net conference, Ghent, Belgium, 17-19 June 2019

10. Workshop 'Visioning ocean futures' at Integrated Marine Biosphere Research (IMBeR) Open Science Conference (OSC), Future Oceans2, Brest, France on 17-21 June 2019

11. Presentation on 'Constructing pathways to achieve the CBD 2050 vision' and a participatory scenario exercise at the Ninth Trondheim Conference on Biodiversity, 2-5 July 2019

12. Presentation and Town Hall event on the NFF. Oceania Ecosystem Services Forum, Christchurch, 3-5 September 2019

13. Presentation on Nature Futures, and the relevance of Essential Biodiversity of Variables (EBVs)' at the First workshop of the Essential Biodiversity Variables 2020 Initiative (EBV2020) for Post-2020 Global Biodiversity Conservation, SERC, USA, 17 Oct 2019

14. Presentation and exercise on the NFF at the 10th World Conference of the Ecosystem Services Partnership, Hannover, Germany, 21-25 October 2019

15. Presentation on the NFF at the Earth System Governance Conference, Oaxaca, Mexico, 6-8 November 2019

16. 'Nature Futures scenarios and modelling & the role of SSH scholars'. IPBES Social Science and Humanities (SSH) Community of Practice Seminar, online, November 2020

17. Webinar 'Developing new nature futures for the IPBES community' for the Natural Capital Project, online, 21 April 2020

18. Webinar 'Operationalizing the NFF', Part of the 'Participatory Governance' webinar series, online, 24 February 2021 Webinar 8 - Operationalizing the Nature Futures Framework - YouTube

19. Presentation at the Fifth science-policy forum for biodiversity and the eighth international conference on sustainability science: Advancing solutions for transition, online, 13-23 April 2021 S1 - Breakout Group 1 - Advancing solutions for transition - YouTube

20. Presentation at an online seminar of the Open-ended Network of IPBES Stakeholders (ONet), 6 May 2021 Video clips from webinar on Degrowth for Biodiversity Conservation | Onet (ipbes.net)

21. Presentation on the NFF to the UN Association of New Zealand at event, 'Unleashing Potentials: Transition to a Sustainable Marine Economy', Wellington & Auckland, New Zealand, 10 June 2021

22. World Biodiversity Forum 2021, Imagining Positive Futures for Biodiversity, 15 June 2021 https://www.youtube.com/watch?v=pkb5QehDrs4

23. Webinar on the NFF for the IPBES external review for the ONet Social Science and Humanities (SSH) Node, online, October 2021

24. Presentation and workshop session on Integrating the IPBES NFF into the implementation of Te Mana o te Taiao (the Aotearoa New Zealand National Biodiversity Strategy and Action Plan). Te Mana o te Taiao alignment workshop, Wellington, New Zealand, 29-30 November 2021

25. 'Enhancing the role of biodiversity scenarios in policy development and implementation for sustainable and positive futures'. Presentation on the NFF at Biodiversa BioDivScen interim project meeting, online, November 2021

26. 'Scenarios for decision making'. Presentation including a discussion on the NFF, at the 'Scenarios and policy in national ecosystem assessments' workshop by the National Ecosystem Assessment Initiative online, January 2022

27. Conference talk 'Introducing the NFF for more positive futures for nature and people', in the session 'Bending the biodiversity curve' of the Netherlands Annual Ecology Meeting, 17 February 2022

28. Workshop 'Nature Futures Framework for the High Seas', Cape Town, South Africa, 28 February - 3 March 2022

Upcoming events

1. Second workshop on modelling nature futures scenarios under the 2030 IPBES rolling work programme, online, 25 and 28 April 2022

2. Catalyzing climate and biodiversity coupled scenarios for assessments and policy, Session at the World Scenarios Forum 20-22 June 2022, Laxenburg, Austria

3. Challenges and opportunities for using the NFF for scenarios and modelling to identify transformative pathways for biodiversity and people; plenary key talk and thematic session at the World Biodiversity Forum, hybrid event, in Davos, Switzerland, 26 June - 1 July 2022

4. Follow up dialogue workshop with experts on indigenous and local knowledge and representatives of indigenous peoples and local communities, September 2022, date to be confirmed.

Appendix IV

List of literature on the nature futures framework[1]

I. Scientific articles (either published or under review) which have used the nature futures framework

Dib, V., Nalon, M.A., Amazonas, N.T., Vidal, C.Y., Ortiz-Rodriguez, I.A., Danek, J., Oliveira, M.F., Alberti, P., Silva, R.A., Gomes, T.F., & Precinoto, R.S. (2020). Drivers of change in biodiversity and ecosystem services in the Cantareira System Protected Area: A prospective analysis of the implementation of public policies. *Biota Neotropica*, *20* (Suppl. 1): e20190915. https://doi.org/10.1590/1676-0611-BN-2019-0915

Diprose, G., Greenaway, A., & Moorhouse, B. (2022). Making Visible More Diverse Nature Futures through Citizen Science. *Citizen Science: Theory and Practice*, *7*(1), p.6. http://doi.org/10.5334/cstp.442

Kim, H., Peterson, G., Cheung, W.W.L, Ferrier, S., Alkemade, A., Arneth, A., Kuiper, J.J., Okayasu, S., Pereira, L., Acosta, L.A., Chaplin-Kramer, R., Den Belder, E., Eddy, T., Johnson, J.A., Karlsson-Vinkhuyzen, S., Kok, M.T.J., Leadley, P.. Leclere, D., Lundquist, C.J. … Pereiera, H. (2021 in preprint). Towards a better future for biodiversity and people: modelling the Nature Futures. SocArXiv. July 22. https://osf.io/preprints/socarxiv/93sqp/

Kuiper, J., van Wijk, D., Mooij, W.M., Remme, R.P., Peterson, G.D., Karlsson-Vinkhuyzen, S., Mooij, C.J., Leltz, G.M., & Pereira, L.M. (2021 in preprint). Exploring desirable nature futures for National Park Hollandse Duinen. Authorea. DOI: 10.22541/au.162792252.23771630/v2

Lembi, R.C., Cronemberger, C., Picharillo, C., Koffler, S., Sena, P.H.A., Felappi, J.F., de Moraes, A.R., Arshad, A; dos Santos, J.P., & Mansur, A.V. (2020). Urban expansion in the Atlantic Forest: applying the Nature Futures Framework to develop a conceptual model and future scenarios. *Biota Neotropica*, *20*, Suppl.1. https://doi.org/10.1590/1676-0611-BN-2019-0904

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Pereira, L. M., Davies, K. K., den Belder, E., Ferrier, S., Karlsson-Vinkhuyzen, S., Kim, H., Kuiper, J. J., Okayasu, S., Palomo, M. G., Pereira, H. M., Peterson, G., Sathyapalan, J., Schoolenberg, M., Alkemade, R., Carvalho Ribeiro, S., Greenaway, A., Hauck, J., King, N., Lazarova, T., . . . Lundquist, C. J. (2020). Developing multiscale and integrative nature–people scenarios using the Nature Futures Framework. *People and Nature*, *2*(4), 1172-1195. https://doi.org/10.1002/pan3.10146

Rana, S., Ávila-García, D., Dib, V., Familia, L., Gerhardinger, L.C., Martin, E., Martins, P.I., Pompeu, J., Selomane, O., Tauli, J.I., Tran, D.H.T., Valle, M., von Below, J., & Pereira, L.M. (2020). The voices of youth in envisioning positive futures for nature and people, *Ecosystems and People*, *16*, 1, 326-344, https://doi.org/10.1080/26395916.2020.1821095

Resende, F.D., Denman, L.A.C., Selva, G.V., Campanhao, L.M.B., Nobre, R.L.G., Jimenez, Y.G., Lima, E.M., & Niemeyer, J. (2020). A conceptual model to assess the impact of anthropogenic drivers on water-related ecosystem services in the Brazilian Cerrado. *Biota Neotropica*, *20*, Suppl.1. https://doi.org/10.1590/1676-0611-BN-2019-0899

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Siqueira-Gay, J., Yanai, A.M., Lessmann, J., Pessoa, A.C.M., Borja, D., Canova, M., & Borges, R.C. (2020). Pathways to positive scenarios for the Amazon forest in Pará state, Brazil. *Biota Neotropica*, *20*, Suppl. 1, e20190905. https://doi.org/10.1590/1676-0611-BN-2019-0905

Yu, D., Tong, W.J., Liu, W., Yi, J., Chen, M., Cao, M., & Xu, H. (2021). A preliminary study on scenarios for biodiversity targets in China based on the 'Nature Futures Framework'. *Journal of Ecology and Rural Environment, 37*, 10, 1234-1241. https://doi.org/10.19741/j.issn.1673-4831.2021.0237

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Borja, D., Daněk, J., Assis, J. C., Gorosábel, A., Lundquist, C., Rosa, I., Scarano, F.R., Amazonas, N.T., Principe, S.C., Alkemade, R., Arshad, A., Benevides Gordillo, S., Cavalcanti Lembi, R., Ferreira Chagas, T.R., Clavijo, D., Cornejo-Denman, L.A., Dib, V., Ferrier, S., Moura Lima, E., … Cabral Borges, R.C. (Dec 2021). The role of new prophets in advancing scenario building for sustainable futures. Submitted, *Global Environmental Change*.

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V.   Other media

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- https://devdunk.itch.io/dont-judge-too-quackly
- https://shoebby.itch.io/the-mediator
- https://pheraone.itch.io/city-to-bee
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