



PBL Netherlands Environmental  
Assessment Agency

REPORT ON THE WORKSHOP  
'GLOBAL MODELLING OF  
BIODIVERSITY AND ECOSYSTEM  
SERVICES'

**June 2019, the Hague, the Netherlands**

PBL

## Report on the workshop 'Global Modelling of Biodiversity and Ecosystem Services'

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### Corresponding author

Sana.Okayasu@pbl.nl

### Authors

Sana Okayasu, Machteld Schoolenberg, Rob Alkemade, Eefje den Belder, Henrique Pereira, Carolyn Lundquist, William Cheung, Carlo Rondinini, Ghassen Halouani, HyeJin Kim, Brian Miller, Tim Hirsch, Rovshan Abbasov, Almut Arneth, Mariteuw Chimère Diaw, Tyler Eddy, Michael Harfoot, Tomoko Hasegawa, Thomas Hickler, Samantha Hill, Florian Humpenöder, Justin Johnson, Marcel Kok, Paul Leadley, David Leclere, Laetitia Navarro, Haruka Ohashi, Garry Peterson, Aafke Schipper, Yunne Shin, Elke Stehfest, Piero Visconti, Detlef van Vuuren

### Contributors

Simon Ferrier, Jan Kuiper, Laura Pereira

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Workshop organisation	Sana Okayasu, Rob Alkemade, Machteld Schoolenberg
Conceptual design and facilitation	Rob Alkemade, Sana Okayasu, Henrique Pereira, Carolyn Lundquist, William Cheung, Carlo Rondinini, HyeJin Kim
Logistical organisation	Sana Okayasu, Zhou Khabjane, Henriët Schaafsma
Preparatory input	Henrique Pereira, Carolyn Lundquist, William Cheung, Carlo Rondinini, HyeJin Kim
Writing - original draft	Sana Okayasu, Machteld Schoolenberg, Ghassen Halouani, HyeJin Kim, Brian Miller
Writing - review & editing	Sana Okayasu, Machteld Schoolenberg, Eefje den Belder

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# MAIN REPORT

## Executive summary

A three-day workshop on 'Global Modelling of Biodiversity and Ecosystem Services', was held in the Hague, Netherlands, from 24<sup>th</sup> to 26<sup>th</sup> June 2019. The workshop, attended by 35 modelling and scenario-building experts, was organised on behalf of the former IPBES<sup>1</sup> expert group on scenarios and models of the first IPBES work programme by its interim technical support unit, and hosted by the PBL Netherlands Environmental Assessment Agency.

The workshop drew on the 'nature futures' participatory scenario-building exercise initiated by the IPBES expert group on scenarios and models, and other biodiversity modelling initiatives such as the ISIMIP project<sup>2</sup> working on adding biodiversity to the Shared Socioeconomic Pathways (SSPs) scenarios framework, the 'bending the curve' initiative<sup>3</sup> led by IIASA<sup>4</sup> and WWF<sup>5</sup>, and GEOBON<sup>6</sup> working on modelling Essential Biodiversity Variables. The workshop was a step towards coordinating across biodiversity modelling initiatives, to build on each other's work, and to seek synergies for the production of innovative scenarios on biodiversity and ecosystem services to inform the post-2020 agenda of the Convention on Biological Diversity, as well as the Sustainable Development Goals. The aims of the workshop were to:

1. Compile material as input for a first draft of the fifth Global Biodiversity Outlook (GBO-5) based on recent scenario work, including the 'bending the curve' scenarios and the newly developed PBL scenarios (modified from the Rio+20 scenarios), and existing models (to be completed by August 2019)
2. Develop a protocol for modelling trends and near term projections on indicators relevant to the Nature Futures Framework<sup>7</sup> using models that are readily available (to be completed by early 2020)
3. Set the agenda and define the aims for a larger meeting at the end of 2019 to discuss the long term strategy towards the development of appropriate indicators and models to produce Nature Futures scenarios (to continue beyond Jan 2020)

The workshop suggested the first steps towards the short, medium, and long-term modelling work which would support the development of IPBES nature futures scenarios. The main results were:

- Formulation of concrete inputs to the 5<sup>th</sup> Global Biodiversity Outlook (workshop aim 1).
- Identification of mid-term and long-term tasks<sup>8</sup> for the further elaboration of the Nature Futures Framework in collaboration with the modelling community:
  - For the mid-term: exploration of possible indicators and metrics to model the three perspectives of the Nature Futures Framework for input to the IPBES participatory scenario-building process and beyond (workshop aim 2).

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<sup>1</sup> The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services: <https://www.ipbes.net/>

<sup>2</sup> The Inter-Sectoral Impact Model Intercomparison Project: <https://www.isimip.org/>

<sup>3</sup> For further information on the initiative see: WWF (2018) Living Planet Report - 2018: Aiming Higher. Grooten, M. and Almond, R.E.A.(Eds). WWF, Gland, Switzerland.

<sup>4</sup> International Institute for Applied Systems Analysis: <https://www.iiasa.ac.at/>

<sup>5</sup> World Wide Fund For Nature: <https://wwf.panda.org/>

<sup>6</sup> The Group on Earth Observations Biodiversity Observation Network: <https://geobon.org/>

<sup>7</sup> Details on the framework can be found at <https://www.pbl.nl/en/publications/report-on-the-workshop-next-steps-in-developing-nature-futures>, and an example of its application at <http://enb.iisd.org/biodiv/cop14/riopavilion/20nov.html>

<sup>8</sup> See Day 3 plenary discussions (p.14).

- For the long-term: identification and prioritisation of key questions<sup>9</sup> for the future nature futures modelling work which could be used for the IPBES scenarios, among others (workshop aim 3).
- For the long-term: identification of challenges and wish lists for the modelling community to elaborate on biodiversity and ecosystem services models for nature-focused scenario processes in the next 3-4 years (workshop aim 3).

The modelling community will continue exchanges through future participation in workshops, joint drafting of papers, joint formulation of draft scenario narratives, and collection of case studies of scenario-building exercises. Participants also expressed a strong wish to see continuity between the nature futures work led by the former expert group and the new task force on scenarios and models under the IPBES rolling work programme, so that the development of new scenarios can be catalysed for future use by IPBES and the broader community. They also recognised that the collaboration within the modelling community has matured sufficiently to not be entirely dependent on the agenda set by the IPBES task force. Strong collaboration between the modelling community and broader stakeholders will ensure the legitimacy and relevance of outputs for policymaking. The dialogue between IPBES experts and the scientific community will continue to be facilitated by the TSU on scenarios and models. Further sharing and uptake of the Nature Futures Framework is expected in other relevant initiatives such as GEOBON in its workshop on Essential Biodiversity Variables.

Finally, the modellers were invited to also explore further links between their work around nature futures and the IPBES work programme up to 2030, and to consider providing timely inputs. Current assessments are on invasive alien species, sustainable use of wild species, and on multiple conceptualisations of values. The new assessment on transformative change is due to be scoped in April 2020. These would be good opportunities to provide input from the nature futures.

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<sup>9</sup> See Annex 6 for the list of questions.

# Introduction

Since the launch of the IPBES methodological assessment of scenarios and models of biodiversity and ecosystem services by the IPBES Plenary in 2016, the expert group on scenarios and models, together with its technical support unit, has been working on its second phase activities to build on the assessment, and to catalyse the further development and use of tools and methodologies on scenarios and modelling.

In addition to providing expert advice to relevant groups on the use of existing scenarios and models, an important part of the expert group's role has been to catalyse the development of a next generation of scenarios and models of biodiversity and ecosystem services by the broader scientific community. These new scenarios are intended to incorporate alternative visions to reach complex intertwined targets, balance synergies and trade-offs between nature conservation and other development goals, and address feedbacks between nature, nature's contributions to people, and human well-being. Through various participatory approaches with stakeholders from relevant sectors, the expert group has identified positive visions on the future of nature, and developed the so-called Nature Futures Framework for the further development of new scenario narratives. The nature futures framework consists of three different perspectives on how people value nature. These perspectives are: *nature for nature*, in which nature is regarded as having value in and of itself, and the preservation of nature's functions is of primary importance; *nature for people*, in which nature is primarily valued for the interest of people, and focus is on the multiple uses of nature; and *nature as culture*, in which humans are perceived as an integral part of nature and its functions. These three perspectives form a continuum, or gradient, that is represented in a triangular nature futures framework, and which can be discussed across different scales and sectors (see background materials, in particular 2 and 3).

The workshop drew on this process and other biodiversity modelling initiatives such as the ISIMIP project working on adding biodiversity to the SSP scenarios framework, the 'bending the curve' initiative led by IIASA and WWF, and GEOBON working on modelling Essential Biodiversity Variables. It was intended as a step towards coordinating across biodiversity modelling initiatives, to build on each other's work, and to seek synergies for the production of innovative scenarios on biodiversity and ecosystem services to inform the post-2020 agenda of the Convention on Biological Diversity, and the Sustainable Development Goals.

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## Background materials

1. Lundquist et al. (2017) Visions for nature and nature's contributions to people for the 21st century (report of the stakeholder workshop held in Auckland)<sup>10</sup>
  2. PBL (2018) Next Steps in Developing Nature Futures (report of the expert group meeting held in The Hague)<sup>11</sup>
  3. PBL (2019), Report on the workshop 'From visions to scenarios for nature and nature's contributions to people for the 21st century'. PBL Netherlands Environmental Assessment Agency, The Hague.<sup>12</sup>
  4. Rosa et al. (2017) Multiscale scenarios for nature futures<sup>13</sup>
  5. Kim et al. (2018) A protocol for an intercomparison of biodiversity and ecosystem services models using harmonized land-use and climate scenarios<sup>14</sup>
  6. IPBES (2016) Summary for policymakers of the methodological assessment on scenarios and models of biodiversity and ecosystem services<sup>15</sup>
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<sup>10</sup> <https://www.niwa.co.nz/coasts-and-oceans/research-projects/ipbes-nature-futures-workshop>

<sup>11</sup> <https://www.pbl.nl/en/publications/report-on-the-workshop-next-steps-in-developing-nature-futures>

<sup>12</sup> <https://www.pbl.nl/en/topics/nature-landscapes-and-biodiversity/publications/from-visions-to-scenarios-for-nature-and-nature-s-contributions-to-people-for-the-21st-century-workshop-report>

<sup>13</sup> <https://www.nature.com/articles/s41559-017-0273-9>

<sup>14</sup> <https://www.qeosci-model-dev.net/11/4537/2018/>

<sup>15</sup> <https://www.ipbes.net/assessment-reports/scenarios>

# Aims and structure of the workshop

## Aims

The workshop's overall goal was to begin coordinating across biodiversity modelling initiatives, to build on each other's work, and to seek synergies for the production of innovative scenarios on biodiversity and ecosystem services to inform the post-2020 agenda of the Convention on Biological Diversity, as well as the Sustainable Development Goals.

The aims of the workshop were to:

1. Compile material as input for a first draft of the fifth Global Biodiversity Outlook (GBO-5) based on recent scenario work, including the 'bending the curve' scenarios and the newly developed PBL scenarios (modified from the Rio+20 scenarios), and existing models (to be completed by August 2019)
2. Develop a protocol for modelling trends and near term projections on indicators relevant to the Nature Futures Framework<sup>16</sup> using models that are readily available (to be completed by early 2020)
3. Set the agenda and define the aims for a larger meeting at the end of 2019 to discuss the long term strategy towards the development of appropriate indicators and models to produce Nature Futures scenarios (to continue beyond Jan 2020)

## Structure

The workshop was held as a combination of plenary sessions with speed-talks from representatives of various modelling groups, and breakout group discussions structured along the three aims of the workshop listed above.

A total of 35 modelling and scenario-building experts attended the three-day workshop, of which 3 experts participated through online communications. The group was of a majority male composition, and of diverse geographical backgrounds: 11% from the Americas, 20% from Asia and the Pacific, 60% from Europe and Central Asia, and 9% from Africa. Four of the participants were early-career experts joining the workshop as IPBES Fellows.

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<sup>16</sup> Details on the framework can be found at <https://www.pbl.nl/en/publications/report-on-the-workshop-next-steps-in-developing-nature-futures>, and an example of its application at <http://enb.iisd.org/biodiv/cop14/riopavilion/20nov.html>

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## Keywords used in the workshop

“Seeds” are innovative initiatives, practices and ideas that are present in the world today, but are not currently widespread or dominant (Bennett et al., 2016<sup>17</sup>; Lundquist et al., 2017<sup>1</sup>).

“Visions” are built on the different seed initiatives from which inspirational stories of sustainable, equitable futures can inspire us to move toward the values and ideals of a “good Anthropocene” (Bennett et al., 2016, Preiser et al., 2017<sup>18</sup>).

“Storylines” are qualitative narratives which provide the descriptive framework from which quantitative exploratory scenarios can be formulated (IPBES glossary<sup>19</sup>).

“Scenarios” are representations of possible futures for drivers of change in nature and nature’s contributions to people (IPBES, 2016<sup>20</sup>), combining storylines with model projections and expert analysis.

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<sup>17</sup> Bennett, E.M., Solan, M., Biggs, R., McPhearson, T., Norström, A.V., Olsson, P., Pereira, L., Peterson, G.D., Raudsepp-Hearne, C., Biermann, F. (2016) Bright spots: seeds of a good Anthropocene. *Frontiers in Ecology and the Environment*, 14(8): 441–448.

<sup>18</sup> Preiser, R., L. M. Pereira, and R. Biggs. 2017. Navigating alternative framings of human-environment interactions: variations on the theme of ‘Finding Nemo.’ *Anthropocene* 20:83-87.  
<http://dx.doi.org/10.1016/j.ancene.2017.10.003>

<sup>19</sup> Accessible from: <https://www.ipbes.net/glossary>

<sup>20</sup> IPBES (2016): The methodological assessment report on scenarios and models of biodiversity and ecosystem services. S. Ferrier, K. N. Ninan, P. Leadley, R. Alkemade, L. A. Acosta, H. R. Akçakaya, L. Brotons, W. W. L. Cheung, V. Christensen, K. A. Harhash, J. Kabubo-Mariara, C. Lundquist, M. Obersteiner, H. M. Pereira, G. Peterson, R. Pichs-Madruga, N. Ravindranath, C. Rondinini and B. A. Wintle (eds.). Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Bonn, Germany. 348 pages. Available from: <https://www.ipbes.net/assessment-reports/scenarios>

# Daily workshop report

## Report from DAY 1 (Monday 24<sup>th</sup> June)

### Opening plenary

#### Welcome remarks by Rob Alkemade (PBL Netherlands Environmental Assessment Agency)

- Hosted by PBL (home of IPBES TSU on scenarios and models), this is a joint workshop of the BES modelling community and the IPBES expert group on scenarios and models.
- The IPBES expert group on scenarios and models completed a methodological assessment (2016), supported scenario chapters in other IPBES assessments (regional, global, LDR) (2017 - 2019), brought modelling groups together for collaboration, and is working on developing new nature scenarios.
- As decided at the IPBES-7 Plenary, the work on scenarios and models will continue under a task force in the rolling work programme of IPBES up to 2030. New calls for experts and TSU have gone out.
- [quick round of introductions]

#### Introduction of expert group's work by Carolyn Lundquist (NIWA and University of Auckland)

- IPBES methodological assessment of scenarios and models; how the scenarios & models fit into the IPBES conceptual framework; different types of scenarios; different scales; why we need new scenarios
- Towards a new generation of nature-centred scenarios: 1) SSP exercises for global scenarios; 2) development of the Nature Futures Framework (Auckland nature futures visioning workshop; The Hague workshop on the Nature Futures Framework)
- Explanation on the Nature Futures Framework: Nature for Nature, Nature as Culture, Nature for Society, which are in line with the IPBES work on values
- Overview upcoming iterative cycles of scenario development, examples of consultations and presentations, representation of the Nature Futures Framework as a 'spaghetti cube'

#### Overview of upcoming modelling work

- Goals for item 1 – Rob Alkemade & Tim Hirsch (Global Biodiversity Outlook)
  - *Workshop aim 1: Compile material as input for a first draft of the fifth Global Biodiversity Outlook based on recent scenario work, including the 'bending the curve' scenarios and the newly developed PBL scenarios (modified from the Rio+20 scenarios), and existing models (to be completed by August 2019)*
  - Preparations for GBO-5 are in parallel to preparations for CBD COP in 2020. The biggest single input is the IPBES global assessment. Can take into account additional work on future narratives (bending the curve, new modelling exercises). Will focus on examples of specific transitions and what they mean for relevant sectors. Fuller draft will go into open review, and the final version shared at 2nd SBSTTA (May/June 2020). August 2019 is the deadline for new content for the narrative, but okay to refer to work that is not yet published. Final references can be added later.
  - Breakout group discussions should also cover potential contributions that can fill possible gaps in the global assessment.
  - Scenarios from the Nature Futures Framework will not be ready for GBO-5.
- Goals for item 2 – Henrique Pereira (iDiv German Centre for Integrative Biodiversity Research) & Simon Ferrier (CSIRO Land & Water)
  - *Workshop aim 2: Develop a protocol for modelling trends and near term projections on indicators relevant to the Nature Futures Framework using models that are readily available (to be completed by early 2020)*

- Previous Vancouver workshop discussed how to move forward. Came up with short and long term approach. Short term is to provide input to the CBD COP next year, based on 3 perspectives of the Nature Futures Framework. Hoping for similar exercise to BES-SIM, this time incorporating remote sensing data on land cover into BES models, mapping trends and sets of indicators into the nature futures perspectives. Perhaps also simple projections into the future (10 years, with GEO BON working groups). Have some funding to organise meetings (one in October 2019, one in Leipzig, January 2020). Present results in June 2020 and publish in special issue. Will not address multi-scales, socio-ecological feedbacks yet.
- Bringing in remote sensing allows exercise based on observed changes. Question about future projections is, whether we simply extrapolate past and present trend lines, or bring in info on trends of drivers (esp. land use and climate). Longer term goal could be to bring in spatio-temporal biological observations.
- Goals for item 3 – William Cheung (The University of British Columbia) & Carlo Rondinini (Sapienza University)
  - *Workshop aim 3: Set the agenda and define the aims for a larger meeting at the end of 2019 to discuss the long term strategy towards the development of appropriate indicators and models to produce Nature Futures scenarios (continues beyond 2020)*
  - Longer term ambitions are to:
    - extend drivers covered (invasive alien species, overexploitation such as hunting in tropical areas, marine environment, protected areas);
    - introduce feedbacks (not only trade-offs between nature conservation and other human needs, also synergies/positive feedbacks such as carbon sequestration, pollination, local climate regulation);
    - incorporate tipping points (need to model the extremes to avoid missing key phenomena such as coral bleaching)
    - tackle outstanding challenges such as multi- and cross-scale scenarios which are computationally challenging
- Clarifications/Q&A
  - Suggestions:
    - Regime shifts are difficult to model, so the Stockholm Resilience Centre has created an open database of regime shifts at [regimeshifts.org](http://regimeshifts.org). There are analyses of this database such as Rocha et al. (2018)<sup>21</sup>.
    - Rockstrom & colleagues at PIK/SRC working on intermediate complexity models. There are models on tipping points/feedbacks for moisture recycling (e.g. Keys et al. (2017)<sup>22</sup>)
  - Timeline? The idea is that our outcomes will feed into ongoing IPBES assessments.
  - Subregional level application? Although there is lack of data at finer scales, some data from a variety of places can be used to calibrate. The short term exercise (group 2) will be looking into indicators, some of which may be useful for subregional level application.
  - Downscaling of narratives into regional scale is crucial, need to develop guidelines for this. Multi-local / multi-site is crucial for successful upscaling. The two scales can enrich each other. Question of how, needs to be discussed this week.
  - Feedbacks / non-linearity / scaling up errors? Need effort to identify crucial gaps in data and explore how to fill or deal with them; this is the biggest challenge.

<sup>21</sup> Rocha, J.C., Peterson, G., Bodin, Ö. and Levin, S. (2018) Cascading regime shifts within and across scales Science, 362(6421), pp.1379-1383.

<sup>22</sup> Keys, P.W., Wang-Erlandsson, L., Gordon, L.J., Galaz, V. and Ebbesson, J., 2017. Approaching moisture recycling governance. Global Environmental Change, 45, pp.15-23.

- Level of ambition and process of putting together these scenarios? Thinking through the approaches is an important part of this discussion. Could be a step-wise approach starting with key transitions instead of targeting all. In Vancouver we spent time working on key socio-ecological feedbacks that stakeholders found important. This would be a useful input into the group 3 discussions.
- The fellows of scenarios and models have submitted a grant proposal to lead a workshop which would promote cross-fertilization with fellows of existing and ongoing assessments. If not successful, new funding may be sought, subject to available opportunities and support from the task force.

### **Plenary: speed-talks**

Participants were requested to give brief updates on new results of their work to be used as input to GBO-5, ideas on the mid-term exercises related to EBVs, and ideas on what they can contribute to the long term strategy. *For details of presentations see Annex 3.*

#### Speed-talks on relevant developments in existing processes

- GEOBON (Laetitia Navarro)
- Fish-MIP (Tyler Eddy)
- ISIMIP (Thomas Hickler)
- Bending the Curve (David Leclere)

#### Speed-talks on relevant developments in existing models

- IAMs (Detlef van Vuuren)
- MAgPIE 4 (Florian Humpenoder)

### **Breakout group discussions**

*For details see break out group notes in Annex 4.*

- Group 1. Inputs to GBO-5
  - Main topics covered:
    - Key transitions to achieve a better future: Bold conservation efforts, land and forest transition, sustainable transitions in various sectors
    - Interpreting the vision “living in harmony with nature” and the pathways
    - What’s missing from the global assessment?
    - How far would we like to take the GBO-5 scenarios beyond those that can realize the 2050 vision? (bending the curve and changing the “game”)
- Group 2. Protocol for mid-term exercise
  - Main topics covered:
    - How to map trajectories in the Nature Futures Framework in a spatially explicit way?
    - Most useful and feasible applications of the Nature Futures Framework?
    - Products and models that could be applied to the Nature Futures Framework
    - Proposed draft structure of metrics for the 3 nature future perspectives, categorized by Biodiversity/State, Society/Benefits, and Management metrics
- Group 3. Long term strategy for building nature futures scenarios
  - Main topics covered:
    - Longer term technical challenges to be tackled
    - Identification of potential feedbacks to cover in the scenarios and uncertainties to consider
    - Possible research developments and collaborations with existing initiatives

## Report from DAY 2 (Tuesday 25<sup>th</sup> June)

### Plenary: speed-talks (continued)

#### Speed-talks on relevant developments in existing models

*For details of presentations see Annex 3.*

- AIM (Tomoko Hasegawa and Haruka Ohashi)
- GLOBIO 4 (Aafke Schipper)
- INSIGHTS (Carlo Rondinini)
- InVEST (Justin Johnson)
- PREDICTS (Samantha Hill)
- DGVM LPJ-GUESS (Almut Arneth)
- Remarks:
  - Looking at most of these outcomes, the main narrative is still biodiversity decline. The big discussion in the literature right now, is that some aspects are declining but others are not. This seems to be missing in our models so we need to consider assumptions and dynamics together. Do the models reflect what is empirically observed? We must take this into account in discussions.
  - Remote contribution (Jan Kuiper): there is a community of freshwater ecosystem modellers - AEMON - who are not engaged with the GBO and IPBES processes. However, considering that freshwater systems, like wetlands, are still underrepresented in Global Assessments where most focus is on land and marine, AEMON could potentially be of importance. So far they have been good in model intercomparison and ensemble modelling, however they mostly focus on specific drivers (e.g. nutrient loading, climate) and have not really connected with integrated scenarios like the SSP's, let alone Nature Futures. It may be good to invite a freshwater modeller representative for one of the coming workshops or potentially organize a Freshwater Modelling IPBES Nature Futures workshop in the future.

### Plenary: recap on breakout group discussions

#### Group 1. Inputs to GBO-5

*For details see break out group notes in Annex 5.*

- Need to include general messages around pathways and futures to summarise and combine messages of all current models and scenarios. Specific summaries of thematic transitions can be included.
- Within the general framework, the Nature Futures Framework will be introduced to highlight the variety of transitions under the different perspectives. Part of that could be incorporated in the thematic summaries as well.
- Develop key messages largely based on bending the curve work. And indicate what can and needs to be done to fulfil this mission.
- Some key messages are more specific than others, depending on how much these solutions or pathways have been elaborated on in models and scenarios that have been taken into account.
- Tim will clean up the key messages and share google doc for participants to provide input within the week. He can share subsequent versions until August for comments on the narrative part. Afterwards, there will be a formal review.
- From the three nature futures perspectives, what are emerging solutions to take us to a better place. Not all have been simulated yet with existing models and scenarios, so might be missed in current stocktaking. A separate section on narratives that have not necessarily been quantified could include this.

- Need to include the impact of consumption and wealth. Consumption is not independent from the division of wealth, so these need to be considered as a cluster of variables. Averages are hugely misleading. Wealth inequality is a tricky political thing, but important to take into account. The global assessment can be referred to. There is much better data on wealth inequality now, so could be taken on board.

### Group 2. Protocol for mid-term exercise AND long term strategy for building nature futures scenarios

See break out notes in Annex 5 for summary of mid- and long-term ideas.

- **Mid-term:** The idea will be to take the three perspectives and set indicators for management, state and benefit. These indicators will be applied to all nature futures perspectives, but some will weigh more for certain perspectives compared to others (*for full list see table in breakout group notes*). These would help the long-term exercise in modelling the nature futures. Sylvia and Laura have funding to do a follow-up workshop, in which we can focus on finding such indicators.
- Key points raised in discussions were:
  - For Nature as Culture: areas under community-based management would be weighted higher. But there is uncertainty on whether these indicators reflect this well. Needs more work to think about better indicators for this perspective.
  - Indigenous landscapes have cultural value. Status of springs, protected sacred sites, the management of these sites, could be Nature as Culture indicators.
  - The challenge for Nature as Culture is finding good data at larger scale. Sacred forests might have at least regional databases. Global data on how they degrade or are protected would be good indicators.
  - For Nature for Society: percentage of sustainable management areas and for marine areas under effective management etc. But challenging for areas where food production increased without water pollution, how to find indicators that show a positive nature for society (utilitarian but not only negative).
- **Long-term:** This will be work at the global scale for the next 3-4 years to build nature futures scenarios. Next milestone could be a workshop early next year building on the outputs of this meeting. We need to have a scenario as a starting point to discuss feedback loops. We might focus on several questions rather than making new scenarios from scratch (see Annex 5 for the initial list of key questions). E.g., for Nature for Nature, questions on implications of Half Earth; for Nature for Society, on which ecosystem service can be minimized for the benefit of biodiversity, etc. By answering these questions, we can move to new positive scenarios, away from the current scenarios which can have negative implications for nature.
- Question to the participants: vote or indicate in the google doc which questions are most important to answer, so we can focus / build on them in our discussions and work plans. From this we will also work on creating a list of people to engage, based on the focus of the selected questions.
  - Criteria: which are the novel questions? Which would be the low hanging fruit, with high / novel outcomes from small changes in models? Which might be best addressed by local case studies or models, and which better with global / regional models? And which could be addressed on several scales?

### **Plenary: preparing for the final day**

Discussion points to address tomorrow:

- Further development of the Nature Futures Framework
  - How are the models to be developed in the coming years, priorities, etc.
  - What can each of the participants do and what are the challenges

- Group work needed on how to rank the key questions to have the long term focus as output of this workshop. And who to invite to the multi-regional workshop
- Uncertainties around the continuation of this work under IPBES
  - Continuation of TSU and selection of experts for the IPBES rolling work programme. Planning hybrid meetings (part IPBES, part non-IPBES) could be interesting solution, how to organise if TSU or certain experts do not continue
  - More resilience could be gained if we consider collective fundraising for this work. This might be the good momentum for this, with the recent publication of the global assessment
  - Thinking about how to broaden our community, connecting to different things people can be doing. Platforms for collaboration could be a better, more time-efficient investment rather than more face-to-face meetings
  - Upcoming: Brazil summer school Carlo (Rob, Carolyn, Simon) with 80 people
- Engaging with sub-global case studies
  - Not just what we are planning, but also other cases that could potentially be using the Nature Futures Framework. Need to prioritise this under WG-4.

## Report from DAY 3 (Wednesday 26<sup>th</sup> June)

### Plenary: speed-talks (continued)

#### Speed-talks on relevant developments in existing models/initiatives

*For details of presentations see Annex 3.*

- Fish-MIP (William Cheung)
- Madingley (Mike Harfoot)
- Naturemap (Piero Visconti)
- Regime shift database (Garry Peterson)
- Teleconnections (Henrique Pereira)
- Discussions/remarks on the speed-talks:
  - What is Half Earth (conserving half of the earth)? Doesn't have to lock people out of nature, can be sustainable use. We assume no harvest, no land-use change, which will not be reality. Major challenge is to be more realistic in what protected areas mean. Often it is not lock out, but this is not incorporated in our models yet.
  - Big risk in model assumptions on lock-out. Also extremely vulnerable areas are not assigned as significant, so is there a bias in the model? We need more nuance in the way we look at biodiversity (non-attractive species can also be fundamental). This is constrained by data availability but we should not base models on popularity only.
  - You use criteria for threat from the IUCN Red List. That cannot go beyond their status no matter the conservation efforts, as restored habitat is needed. So even with Half Earth you cannot cover their distributions? Surprising how little difference there is between Half Earth and Aichi in terms of species conservation.
  - How to do these models across scales, and how to include consumption/production perspectives? This would be important for nature futures. The BES-SIM paper shows significant variation between models in projections of local species richness change. Need to discuss this. The iDiv model shows local increase in species richness, but global decrease. Species are colonizing habitats that are being opened up. Biodiversity change may be more complex than what we are representing in our models. The Essential Biodiversity Variables in the GEO BON data portal show biodiversity increase in Europe since beginning 20th century.
  - Species extinction, population declines, species richness is horribly insensitive to biodiversity. So are we modelling the wrong indicators? The discussion has been on the role of species richness in maintaining ecosystem functioning, but we have to tell a richer story that connects with real world discussions. If our models just paint the same picture as land cover change, that misses the discussions on biodiversity.
  - When we use our common sense, does Europe as a whole have more species compared to 1910? Results apply only for birds or mammals. Very local species richness might be higher (e.g. in city parks), but around them are green deserts.
  - We should not confuse species richness with richness of certain species. We need to reduce oversimplification and include complex global system, e.g. teleconnections.
  - Main point: getting a richer story of biodiversity change. Key is stronger stakeholder dialogue with end users, what they need, how our work is interpreted, and understood. Different preferences in the most important indicators.

### Plenary discussions

Participants were invited to give brief statements on what they identified as challenges or as a wish list for the next few years. A wide range of issues were raised:

### Scope of models

- The focus is still in global models on number of species and IUCN Red List, need to broaden.
- Quantify/incorporate relationships between biodiversity - ecosystem functioning/services (possibly including human health).
- Time lags in these scenarios, nonlinear dynamics. Not only species response to change, but other ecosystem responses to changes as well.
- Extreme events such as drought, flooding, etc., and impacts on crops and biodiversity.
- Climate change adaptation: how to adapt optimally to climate change in relation to protected area spatial planning.
- Better characterization of biodiversity responses to different management practices and levels, and understanding regional differences.
- Land-use modelling focuses on how land-use changes, but how cropland is managed or used can have more attention (monoculture, agroforestry, etc.).
- Impact climate mitigation on biodiversity, not clear yet. To get more insight if we can bend the curve at all. Agree that there is a lot of work to be done on richness.
- Agricultural intensification (benefits and disadvantages for biodiversity) to feed world. To capture that is a big challenge.
- Missing piece: to explain the future, not only model land, but also external pressures.
- Solution focus, mitigation aspects and impact on biodiversity. For adaptation, incorporating changes in oceans, explore whether there are interventions that can promote adaptations of organisms.
- Climate change effects on biodiversity. If it is bigger than the effect of land use true, is mitigation always good, regardless of trade-offs? Need to look into this. Land use models are historical data-driven, and climate change models not validated. Different levels of uncertainty between land use and climate change impacts. Need to understand these, in order to give the right messages to policy community.
- Mental map / conceptual diagrams would be cool to do, for some case studies. From nature futures perspectives, good to look at range of things, plant/land-sharing between Nature as Culture, Nature for Society, Nature for Nature.

### How to model

- Making biodiversity models more comprehensive and internally consistent (notably climate vs land-use) in terms of pressures covered (including interactions)
- Assess the importance of indirect and cascading effects (e.g. changes in biotic interactions due to climate change)
- More coordinated effort to connect between realms which will become more prevalent with emerging nexus studies.
- Linking driver and impact models in land use. Quick possible improvement, in IAMs, what is the land that is not used. Information on forest types is also useful.
- Collectively target region where we can easily do assessments.
- Developing scenario looking into solutions, exploratory scenarios. IMAGE: SDG agenda, see how to achieve multiple targets at the same time (including trade-offs).
- For biodiversity, if we want to explore solutions and there are trade-offs, need relationships between IAMs and biodiversity models, and be relatively reassured that we model pressures in comparable way.
- Network approaches: alternatives linking to land based approaches to cover its flaws / fill the gaps.
- There is a need to consider the different sources of uncertainties in our models (process errors, observation errors, implementation errors etc.) for better advice. Example of implementation error: locked out protected areas actually not locked out, etc.

### Links to social issues

- Better process based models that link biodiversity and social issues.
- Capture feedbacks to society. Stronger links to more sectors, e.g. water, health.
- Interaction nature and social system. Conceptual mapping of feedbacks.
- Systematic coupling of biodiversity outcome and equity outcomes is crucial.
- Inequality is related to biodiversity loss. So rather distributional indicator than averages of wealth such as GDP. E.g., social inequality leads to bad management.

### Scale issues

- Matching global and regional models. Huge differences now probably due to coarse output of earth system models.
- Regime shifts: potential to have global process-based shifts, and local processes in local models, but also bridging these mechanisms between them.
- Increase capacity to model on multiple scales.

### **Breakout groups**

Identification and prioritisation of key questions in 4 breakout groups:

*(See Annex 6 for detailed notes and lists of questions)*

#### 1. Nature for Nature

- Applied the criteria, and added policy impacts. Assessed all the questions and reworded to fit Nature for Nature; occasionally also moved questions to other corners where we thought it applicable. Grouped some together, in total 6 questions now.

#### 2. Nature for Society

- Ended with 19 questions mapped on a scale of difficulty and importance.
- Main question is how to improve ecosystem services provision by linking to landscape and biodiversity, and what are implications for economy, health, etc. How to optimize ecosystem services without ecological decline or with improved biodiversity.

#### 3. Nature as Culture

- Revised questions, e.g. first question to include local food; and added questions, e.g. usefulness of rewilding for urban landscapes in Europe. Added a table to score them along criteria.

#### 4. Cross-cutting /Undefined

- Table in separate google doc with 14 questions and criteria. Ranked two questions as very feasible and somewhat novel, and two as very novel and somewhat feasible.

### **Plenary discussions on next steps**

#### Continuation of work with IPBES

- Even though IPBES will select a new task force, the community can continue this work.
- Also need to consider questions coming from IPBES with the new assessments, such as the sustainable use assessment (already requests for input).
- Worth thinking about relationship with IPBES work and timely inputs to IPBES. Nature as culture and food/diet could be an interesting link to feed into the new nexus assessment. The transformative change assessment would be perfect to provide input from the nature futures. But important to keep in mind that we do not only serve the IPBES assessments.

- Transformative change assessment will be scoped in April 2020.
- Current assessments are: invasive alien species, sustainable use, and values.

#### Possible way forward for nature futures modelling work

- Between now and next workshop, let's collaboratively set up groups that start working on some of these narratives. And think about link between nature futures and SSPs.
- Opportunity to use these key questions to guide the preparations for the next workshop. What to start working on beforehand, and if and how they could be tackled. These questions feed into IPBES work, but are also policy relevant outside of IPBES.
- Could organise a parallel storyline group as an IPBES spin-off, but needs to be explored by former co-chairs and TSU and WG leads.
- For the next workshop, focus on key questions or on narratives?
  - The last two meetings hoped to produce scenarios storylines, but could not reach agreement on which scenarios to build (corners or middle points). But without them there is confusion on how to use and interpret the Nature Futures Framework. Maybe just start with drafting some storylines of the nature futures scenarios?
  - Storyline is important at this point to start testing scenarios in these modelling groups. In parallel, interesting to identify indicators that would allow for a broader set of scenarios to be mapped in the Nature Futures Framework. We call this the 'duality' principle where existing scenarios can be scored in the Nature Futures Framework, or new storylines can be created from the Nature Futures Framework.
- What is a legitimate way to produce these storylines?
  - Legitimacy can come from wider scientific group developing these. Similar to IPCC, getting communities to come together to work on this could be the legitimacy of the IPBES group's product. From a certain point it is no longer owned by only IPBES, although not independent either. Perhaps it is mature enough to become a hybrid and feed into IPBES while being developed independent of it.
  - In IPCC, scenario process was part of it. In the 2005/6 meeting on continuation, it was decided not to develop the scenarios fully. IPCC then called on the scientific community to ensure continuation, with an official letter calling on those willing to pick up the work. The upside was having more flexibility but legitimacy was a problem. For RCPs, a paper was published in Nature to invite others to join. For SSPs, the process started with an open conference to invite people to the scoping and storyline development. Still, communities don't feel the ownership.
  - The next TSU will still have the mandate to support this whole process. In that sense, this will remain a dialogue between IPBES, the community and TSU. On ownership and development, formally IPBES' mandate is only to catalyse.
  - One way to move forward while ensuring continuity, could be to make draft scenarios and framework, and then to do a broader stakeholder consultation on them.
  - Legitimacy in IPBES is also about different knowledge systems. We have a lot of output from previous consultations that we have not used yet. The first step towards draft storylines should be to use what we have gathered from the stakeholders and put into one database. It is also key to tie in other sub-regional consultations led by former IPBES expert group members.
  - Funding would also be important to move this forward.
  - Challenge is getting the prototype idea. We have materials from previous inputs, but haven't pinpointed where in the Nature Futures Framework these scenarios would sit. Prefer to hand over something to new group, rather than them starting from scratch.
  - The fellows can bridge between the old and new team, together with the former expert group and TSU.

- Concrete way forward could be to task interested experts and the fellows to draft a few storylines in different parts of the Nature Futures Framework (centre, another on corners, another on the sides of the triangle, etc). With all these stories, we have the start of a new discussion. We can make sure they are connecting by aligning certain axes, structure, etc. Starting and iterating on this makes the most sense.
- Interesting to touch base after we have the different types of storylines, the back-casting exercise based on the EBVs, and other ongoing sub-regional exercises (Brazil, China, etc.). Also to think about how to bring us to the local case studies (WG-4) drawing on these three lines of work.
- Who is going to organise this?
  - We can decide on that after the selection of co-chairs and TSU (expected to take until September for establishment of task force and TSU). But should convey to IPBES and the MEP and Bureau that as the scientific community we would like to see this continuity regardless of individuals selected. IPBES also wants to support this community, so very unlikely that there will be complete change of people and plans.
  - Even in the worst case scenario with all plans changing, if this community still wants to continue, we could plan a meeting anyway by finding other funding sources. The current TSU continues until December, by when the new task force will be ready.
  - The formal mandate of the new task force is the continuation of the expert group's work, but in terms of executive details, they are not obliged to follow all our plans. The new scenarios are not referred to as nature futures, but how they interpret this is to be seen.
  - An online group like google groups could be set up to keep communications going.

#### Plans for producing papers

- We have this roadmap paper started at the last workshop in Vancouver, and would be good to have some people from this meeting join in. The roadmap has evolved since the last meeting as well, so we will invite you into this paper.
- Another very important paper on the Nature Futures Framework was rejected by the Science Policy Forum. But One Earth just got back to us that they are interested, either as commentary or a longer article. The former expert group would need to adjust the content accordingly and send it in.

#### Next steps for the modelling community

- Most participants will be invited for the back-casting exercise organised by GEO BON.
- Continue online communication of this modelling community and IPBES task force.
- Join the drafting of the roadmap paper on the further development of nature futures.
- Join the exercise of narrative writing, which might not have to wait until the next task force is set up. Would need a small guiding group of volunteers for this: Garry Peterson, Detlef van Vuuren
- Collect information on ongoing case studies (WG-4). Is there a way of compiling their information? Garry Peterson, Jan Kuiper, Isabel Rosa, Federica Ravera have developed a beta website to gather socio-ecological scenarios (scheduled to work by September). Not only designed for IPBES but makes sense to use it.

# Outcomes of the workshop

From a series of plenary speed-talks on the ongoing modelling work by representatives from various modelling groups, breakout group discussions, and plenary discussions, the workshop resulted in the following outcomes:

- Formulation of concrete inputs to the 5<sup>th</sup> Global Biodiversity Outlook (workshop aim 1).
- Identification of mid-term and long-term tasks for the further elaboration of the Nature Futures Framework in collaboration with the modelling community:
  - For the mid-term: exploration of possible indicators and metrics to model the three perspectives of the Nature Futures Framework for input to the IPBES participatory scenario-building process and beyond (workshop aim 2).
  - For the long-term: identification and prioritisation of key questions for the future nature futures modelling work which could be used for the IPBES scenarios, among others (workshop aim 3).
  - For the long-term: identification of challenges and wish lists for the modelling community to elaborate on biodiversity and ecosystem services models for nature-focused scenario processes in the next 3-4 years (workshop aim 3).
- Sharing understanding on the way forward for the nature futures work:
  - Clarification of the status and schedule for the nature futures work under IPBES.
  - Sharing of plans for the production of outputs from the nature futures work.
- Agreement on continued collaboration with the modelling community:
  - Most participants to be invited for the back-casting exercise organised by GEO BON.
  - Continue online communication of this modelling community and IPBES task force.
  - Join the drafting of the roadmap paper on the modelling of nature futures.
  - A small guiding group of volunteers, likely including experts, TSU members, and fellows, would be needed for the narrative writing exercise based on materials developed and collected to date.
  - Collect information on ongoing case studies of scenario building exercises.

# Conclusions

- The workshop served as an opportunity for various modelling groups to jointly formulate concrete inputs to the text of the 5th Global Biodiversity Outlook (workshop aim 1).
- Further sharing and uptake of the Nature Futures Framework is expected in other relevant initiatives such as GEOBON in its workshop on Essential Biodiversity Variables, which will contribute to the mid-term modelling work (workshop aim 2).
- The workshop has identified a set of key questions<sup>23</sup> that can guide the next steps in the nature futures modelling work. These questions feed into IPBES work, but are also policy relevant outside of IPBES (workshop aim 3).
- Another important step recognised by the modelling community is the formulation of draft scenario narratives using the previous inputs collected from a diverse range of stakeholders, which would need to be followed by a broader stakeholder consultation through a participatory process (workshop aim 3).
- The modelling community hopes to see continuity between the nature futures work led by the former expert group and the new task force on scenarios and models under the IPBES rolling work programme. This would ensure that the drafting of storylines and addressing of key questions can continue towards the development of new scenarios for future use by IPBES and the broader community.
- In pursuing the development of nature futures scenarios, the collaboration within the modelling community has matured sufficiently to not be entirely dependent on the agenda set by the IPBES task force. Strong collaboration between the modelling community and broader stakeholders will ensure the legitimacy and relevance of outputs for policymaking. The dialogue between IPBES experts and the scientific community will continue to be facilitated by the TSU on scenarios and models.
- The modellers will also explore further links between their work around nature futures and the IPBES work programme up to 2030, and consider providing timely inputs. Current assessments are: invasive alien species, sustainable use of wild species, and on multiple conceptualisations of values, and the new assessment on transformative change will be scoped in April 2020. These would be good opportunities to provide input from the nature futures. Nature as culture and food/diet could also be an interesting link to feed into the new nexus assessment.

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<sup>23</sup> See Annex 6 for the list of questions.

## ANNEXES

# Annex 1. List of participants

**Aafke Schipper**

PBL Netherlands Environmental  
Assessment Agency  
[A.Schipper@science.ru.nl](mailto:A.Schipper@science.ru.nl)

**Almut Arneth**

Karlsruhe Institute of Technology  
[almut.arneth@kit.edu](mailto:almut.arneth@kit.edu)

**Brian Miller**

United States Geological Survey  
IPBES Fellow on scenarios and models  
[bwmiller@usgs.gov](mailto:bwmiller@usgs.gov)

**Carlo Rondinini**

Sapienza University  
IPBES expert group on scenarios and  
models  
[carlo.rondinini@uniroma1.it](mailto:carlo.rondinini@uniroma1.it)

**Carolyn Lundquist**

NIWA and University of Auckland  
Co-chair of IPBES expert group on  
scenarios and models  
[Carolyn.Lundquist@niwa.co.nz](mailto:Carolyn.Lundquist@niwa.co.nz)

**David Leclere**

International Institute for Applied Systems  
Analysis (IIASA)  
[leclere@iiasa.ac.at](mailto:leclere@iiasa.ac.at)

**Detlef van Vuuren**

PBL Netherlands Environmental  
Assessment Agency  
[Detlef.vanVuuren@pbl.nl](mailto:Detlef.vanVuuren@pbl.nl)

**Elke Stehfest**

PBL Netherlands Environmental  
Assessment Agency  
[Elke.Stehfest@pbl.nl](mailto:Elke.Stehfest@pbl.nl)

**Florian Humpenöder**

Potsdam Institute for Climate Impact  
Research  
[florian.humpenoeder@pik-potsdam.de](mailto:florian.humpenoeder@pik-potsdam.de)

**Garry Peterson**

Stockholm Resilience Centre, Stockholm  
University  
IPBES expert group on scenarios and  
models  
[garry.peterson@su.se](mailto:garry.peterson@su.se)

**Ghassen Halouani**

Galway-Mayo Institute of Technology  
IPBES Fellow on scenarios and models  
[ghassen.halouani@gmit.ie](mailto:ghassen.halouani@gmit.ie)

**Haruka Ohashi**

Forestry and Forest Products Research  
Institute  
[oharu0429@gmail.com](mailto:oharu0429@gmail.com)

**Henrique Pereira**

iDiv German Centre for Integrative  
Biodiversity Research  
Co-chair of IPBES expert group on  
scenarios and models  
[hpereira@idiv.de](mailto:hpereira@idiv.de)

**HyeJin Kim**

iDiv German Centre for Integrative  
Biodiversity Research  
IPBES Fellow on scenarios and models  
[hyejin.kim@idiv.de](mailto:hyejin.kim@idiv.de)

**Justin Johnson**

University of Minnesota  
[jandrewjohnson@gmail.com](mailto:jandrewjohnson@gmail.com)

**Laetitia Navarro**

iDiv German Centre for Integrative  
Biodiversity Research  
[laetitia.navarro@idiv.de](mailto:laetitia.navarro@idiv.de)

**Marcel Kok**

PBL Netherlands Environmental  
Assessment Agency  
[Marcel.Kok@pbl.nl](mailto:Marcel.Kok@pbl.nl)

**Mariteuw Chimère Diaw**

African Model Forests Network  
IPBES multidisciplinary expert panel  
[c.diaw@africanmodelforests.org](mailto:c.diaw@africanmodelforests.org)

**Michael Harfoot**

UN Environment World Conservation  
Monitoring Centre  
[mike.harfoot@unep-wcmc.org](mailto:mike.harfoot@unep-wcmc.org)

**Paul Leadley**

Université Paris-Sud  
[paul.leadley@u-psud.fr](mailto:paul.leadley@u-psud.fr)

**Piero Visconti**

International Institute for Applied Systems  
Analysis (IIASA)  
[pierovisconti@gmail.com](mailto:pierovisconti@gmail.com)

**Rovshan Abbasov**

Khazar University  
IPBES multidisciplinary expert panel  
[abbasov@fulbrightmail.org](mailto:abbasov@fulbrightmail.org)

**Samantha Hill**

UN Environment World Conservation  
Monitoring Centre  
[Samantha.hill@unep-wcmc.org](mailto:Samantha.hill@unep-wcmc.org)

**Thomas Hickler**

Senckenberg Biodiversity and Climate  
Research Centre  
[thomas.hickler@senckenberg.de](mailto:thomas.hickler@senckenberg.de)

**Tim Hirsch**

Global Biodiversity Outlook  
[thirsch@gbif.org](mailto:thirsch@gbif.org)

**Tomoko Hasegawa**

Ritsumeikan University  
[thase@fc.ritsumei.ac.jp](mailto:thase@fc.ritsumei.ac.jp)

**Tyler Eddy**

University of South Carolina  
[Tylereddy@gmail.com](mailto:Tylereddy@gmail.com)

**William Cheung**

The University of British Columbia  
IPBES expert group on scenarios and  
models  
[w.cheung@oceans.ubc.ca](mailto:w.cheung@oceans.ubc.ca)

**Yunne Shin**

IRD  
[yunne-jai.shin@ird.fr](mailto:yunne-jai.shin@ird.fr)

**Jan Kuiper**

Stockholm Resilience Centre, Stockholm  
University  
IPBES Fellow on scenarios and models  
[jan.kuiper@su.se](mailto:jan.kuiper@su.se)

**Laura Pereira**

City, University of London  
IPBES expert group on scenarios and  
models  
[Laura.Pereira@city.ac.uk](mailto:Laura.Pereira@city.ac.uk)

**Simon Ferrier**

CSIRO Land & Water  
IPBES expert group on scenarios and  
models  
[Simon.Ferrier@csiro.au](mailto:Simon.Ferrier@csiro.au)

**Machteld Schoolenberg**

PBL Netherlands Environmental  
Assessment Agency  
IPBES Technical support unit on scenarios  
and models  
[Machteld.Schoolenberg@pbl.nl](mailto:Machteld.Schoolenberg@pbl.nl)

**Rob Alkemade**

PBL Netherlands Environmental  
Assessment Agency  
IPBES Technical support unit on scenarios  
and models  
[Rob.Alkemade@pbl.nl](mailto:Rob.Alkemade@pbl.nl)

**Sana Okayasu**

PBL Netherlands Environmental  
Assessment Agency  
IPBES Technical support unit on scenarios  
and models  
[Sana.Okayasu@pbl.nl](mailto:Sana.Okayasu@pbl.nl)

# Annex 2. Final programme of the workshop

## DAY 1: Monday 24th June

Time & Available rooms	Agenda items
8h30-9h00	<i>Arrival &amp; registration</i>
9h00-10h10 <b>Plenary</b> At the New Babylon conference facility	<b>Plenary</b> <ul style="list-style-type: none"> <li>• Welcome/opening – Rob Alkemade (5 mins)</li> <li>• Introduction of expert group’s work – Carolyn Lundquist (15 mins)</li> <li>• Overview of upcoming modelling work               <ul style="list-style-type: none"> <li>- Goals for item 1 – Rob Alkemade &amp; Tim Hirsch (10 mins)</li> <li>- Goals for item 2 – Henrique Pereira &amp; Simon Ferrier (10 mins)</li> <li>- Goals for item 3 – William Cheung &amp; Carlo Rondinini (10 mins)</li> </ul> </li> <li>• Clarifications/Q&amp;A (10 mins)</li> </ul>
10h00-10h30	<i>Coffee break</i>
10h30-11h50 <b>Plenary</b> At the New Babylon conference facility	<b>Plenary</b> <ul style="list-style-type: none"> <li>• Speed-talks on relevant developments in other groups <i>Participants to give <b>brief</b> updates on new results of their work to be used as input to GBO-5, ideas on the mid-term exercises related to EBVs, and ideas on what they can contribute to the long term strategy.</i> <ul style="list-style-type: none"> <li>- <i>On existing processes:</i> <ul style="list-style-type: none"> <li>▪ GEOBON (Laetitia Navarro)</li> <li>▪ FISHMIP (Tyler Eddy)</li> <li>▪ ISIMIP (Thomas Hickler)</li> <li>▪ Bending the Curve (David Leclere)</li> </ul> </li> <li>- <i>On existing models:</i> <ul style="list-style-type: none"> <li>▪ IAMs (Detlef van Vuuren)</li> <li>▪ MAgPIE 4 (Florian Humpenoder)</li> </ul> </li> </ul> </li> </ul> <i>... Remaining speed-talks continued on subsequent days</i>
11h50-13h00	Walk to PBL (10 mins) <i>Lunch (at PBL)</i>
13h00-15h00 <b>Breakout</b> Helmgraszaal (16 ppl) Parnassiazaal (10 ppl) Pyrolazaal (10 ppl)	<b>Breakout groups</b> <ol style="list-style-type: none"> <li>1. Inputs to GBO-5</li> <li>2. Protocol for mid-term exercise</li> <li>3. Long term strategy for building nature futures scenarios</li> </ol>
15h00-15h30	<i>Coffee break → Rotate groups</i>
15h30-17h00 <b>Breakout</b> Helmgraszaal (16 ppl) Parnassiazaal (10 ppl) Pyrolazaal (10 ppl)	<b>Breakout groups</b> <ol style="list-style-type: none"> <li>1. Inputs to GBO-5</li> <li>2. Protocol for mid-term exercise</li> <li>3. Long term strategy for building nature futures scenarios</li> </ol>
17h00-17h30 <b>Plenary</b> Werkfoyer	<b>Touch-base</b> Updates on the schedule of the next day

## DAY 2: Tuesday 25th June

<b>Time &amp; Available rooms</b>	<b>Agenda items</b>
<i>8h30-9h00</i>	<i>Arrival &amp; registration</i>
9h00-10h00 <b>Plenary</b> Zeedistelzaal (30 ppl) Larger room shared by two groups	<b>Plenary</b> <ul style="list-style-type: none"> <li>• Speed-talks on relevant developments in other groups (cont.)               <ul style="list-style-type: none"> <li>- <i>On existing models:</i> <ul style="list-style-type: none"> <li>▪ AIM (Tomoko Hasegawa)</li> <li>▪ GLOBIO 4 (Aafke Schipper)</li> <li>▪ INSIGHTS (Carlo Rondinini)</li> <li>▪ InVEST (Justin Johnson)</li> <li>▪ PREDICTS (Samantha Hill)</li> <li>▪ DGVMs (LPJ-GUESS) (Almut Arneth)</li> </ul> </li> </ul> </li> </ul>
<i>10h00-10h30</i>	<i>Coffee break</i>
10h30-12h00 <b>Breakout</b> Duinzaal (20 ppl) Pyrolazaal (10 ppl) Larger room shared by two groups	<b>Breakout groups</b> <ol style="list-style-type: none"> <li>1. Inputs to GBO-5</li> <li>2. Protocol for mid-term exercise AND 3. Long term strategy for building nature futures scenarios</li> </ol>
<i>12h00-13h00</i>	<i>Lunch break</i> Change of rooms for larger group
13h00-15h30 <b>Breakout</b> Buntgraszaal (16 ppl) Pyrolazaal (10 ppl)	<b>Breakout groups</b> <ol style="list-style-type: none"> <li>1. Inputs to GBO-5</li> <li>2. Protocol for mid-term exercise AND 3. Long term strategy for building nature futures scenarios</li> </ol>
<i>15h30-15h50</i>	<i>Coffee break</i> Additional breakout room becomes available
15h50-17h00 <b>Plenary</b> Zeedistelzaal (30 ppl)	<b>Touch-base</b> Group report-back and updates on the schedule of the next day

## DAY 3: Wednesday 26th June

Time & Available rooms	Agenda items
8h30-9h00	Arrival & registration
9h00-11h00 <b>Plenary</b> Zeedistelzaal (30 ppl)	<p><b>Plenary</b></p> <ul style="list-style-type: none"> <li>• Speed-talks on relevant developments in other groups (cont.) <ul style="list-style-type: none"> <li>- <i>On existing models/initiatives:</i> <ul style="list-style-type: none"> <li>▪ FISHMIP (William Cheung)</li> <li>▪ Madingley (Mike Harfoot)</li> <li>▪ Naturemap (Piero Visconti)</li> <li>▪ Regime shift database (Garry Peterson)</li> <li>▪ Teleconnections (Henrique)</li> </ul> </li> </ul> </li> <li>• Identification of remaining discussion points</li> </ul>
11h00-11h30	<p><i>Coffee break</i></p> <p>Vacate large plenary room</p>
11h30-12h30 <b>Breakout</b> Duinzaal (20 ppl) Parnassiazaal (10 ppl)	<p><b>Breakout groups</b></p> <ul style="list-style-type: none"> <li>• Identification and prioritisation of key questions to be addressed <ul style="list-style-type: none"> <li>- <i>Split into 4 groups:</i> <ol style="list-style-type: none"> <li>1. Nature for Nature</li> <li>2. Nature for Society</li> <li>3. Nature as Culture</li> <li>4. Cross-cutting /Undefined</li> </ol> </li> </ul> </li> </ul>
12h30-13h30	<i>Lunch break</i>
13h30-15h00 <b>Breakout</b> Duinzaal (20 ppl) Parnassiazaal (10 ppl) (also plenary room available from 14h00)	<p><b>Breakout groups</b></p> <ul style="list-style-type: none"> <li>• Identification and prioritisation of key questions to be addressed (cont.) <ul style="list-style-type: none"> <li>- <i>Split into 4 groups:</i> <ol style="list-style-type: none"> <li>1. Nature for Nature</li> <li>2. Nature for Society</li> <li>3. Nature as Culture</li> <li>4. Cross-cutting /Undefined</li> </ol> </li> </ul> </li> </ul>
15h00-15h30	<i>Coffee break</i>
15h30-17h00 <b>Plenary</b> Zeedistelzaal (30 ppl)	<p><b>Plenary</b></p> <ul style="list-style-type: none"> <li>• Report-back from groups</li> <li>• Discussion of roadmap for nature futures modelling work</li> </ul>
17h00 <b>Plenary</b> Zeedistelzaal (30 ppl)	<b>Closing of the workshop</b>

## EXTRA DAY: Thursday 27th June

(extra day led by IIASA and WWF for a small 'bending the curve' meeting)

## Breakout Groups of the week

### Day 1

- Group 1 (Inputs to GBO-5): Tim Hirsch, Rob Alkemade (facilitators), Carolyn Lundquist, Paul Leadley, Chimere Diaw, Marcel Kok, Samantha Hill (session 1), David Leclere, Tomoko Hasegawa, Elke Stehfest, Yunne Shin, Ghassen Halouani (notes)
- Group 2 (Protocol for mid-term exercise): Henrique Pereira, Laetitia Navarro (facilitators), Justin Johnson, Tyler Eddie, Thomas Hickler, Haruka Ohashi, Samantha Hill (session 2), Brian Miller (notes)
- Group 3 (Long term strategy for nature futures): Carlo Rondinini, William Cheung (facilitators), Aafke Schipper, Almut Arneth, Sana Okayasu, Mark Harfoot, Rovshan Abbasov, Garry Peterson, Florian Humpenoder, Thomas Hickler, Yunne Shin, David Leclere, Tomoko Hasegawa, HyeJin Kim (notes)

### Day 2

- Group 1 (Inputs to GBO-5): Tim Hirsch, Rob Alkemade (facilitators), Carolyn Lundquist (notes), Tomoko Hasegawa, Elke Stehfest, Aafke Schipper, Rovshan Abbasov, Justin Johnson, Florian Humpenoder, Paul Leadley, David Leclere (AM), Marcel Kok (AM), Carlo Rondinini (PM), Samantha Hill (PM), Ghassen Halouani (notes)
- Group 2 (Mid-term and long term strategy for nature futures): William Cheung (facilitator), Carlo Rondinini (AM), Henrique Pereira, Laetitia Navarro, Tyler Eddie, Thomas Hickler, Haruka Ohashi, Samantha Hill (AM), Almut Arneth, Sana Okayasu, Mark Harfoot, Garry Peterson, Chimere Diaw, Brian Miller (notes), HyeJin Kim (notes)

### Day 3

- Group 1 (Nature for Nature): William Cheung (facilitator), Piero Visconti (AM), David Leclere, Haruka Ohashi, Almut Arneth, Rovshan Abbasov, HyeJin Kim (notes)
- Group 2 (Nature for Society): Garry Peterson (facilitator), Rob Alkemade, Samantha Hill, Detlef van Vuuren, Justin Johnson, Brian Miller (notes)
- Group 3 (Nature as Culture): Carolyn Lundquist (facilitator/notes), Tyler Eddy, Ghassen Halouani, Aafke Schipper, Paul Leadley
- Group 4 (Cross-cutting): Henrique Pereira (facilitator), Carlo Rondinini, Chimere Diaw, Laetitia Navarro, Mike Harfoot, Florian Humpenoder, Tomoko Hasegawa, Piero Visconti (PM), Sana Okayasu (notes)

# Annex 3. Speed-talks

Participants were requested to give brief updates on new results of their work to be used as input to GBO-5, ideas on the mid-term exercises related to EBVs, and ideas on what they can contribute to the long term strategy.

## DAY 1

### Speed-talks on relevant developments in existing processes

- GEOBON (Laetitia Navarro): mission is to improve acquisition, coordination and delivery of biodiversity observations and related services to users including decision makers and the scientific community. One of the core efforts: developing Essential Biodiversity Variables (EBVs): minimum set of measurements, complementary to one another, that can capture major dimensions of biodiversity change. EBVs in six classes, each with a working group. Timeline is to have 1-2 EBV datasets per class available in June 2020 on GEO BON portal.
- Fish-MIP (Tyler Eddy): future scenarios for the ocean as part of ISI-MIP framework. 3 regional modelling types in 8 regions; 7 global models; Earth system models (climate data) and fishing effort (socio economic scenarios) as input for marine ecosystem and fisheries models. Comparison paper "Global ensemble projections reveal trophic amplification of ocean biomass declines with climate change" - Lotze et al PNAS. // paper "From SSPs to ocean system pathways". In Vancouver workshop, started thinking about the Nature Futures Framework and future Fish-MIP scenarios. Several working groups with different disciplines of scientist but also FAO and other stakeholders. Fish-MIP workshop in Rome 23-25 Oct 2019.
- ISIMIP (Thomas Hickler): 55 model contributions to ISIMIP2b. Climate mitigation with expansion of bioenergy as bad as a strong climate change without bioenergy expansions (Hof et al 2018 PNAS). Biome and vegetation structural shifts more important than climate and perhaps land-use change (Hickler et al 2006 GEB; Thom as al 2008 EMBO reports).
- Bending the Curve (David Leclere): analysis emerged from a need to investigate ambitious actions for biodiversity (Mace et al 2018 Nat Sus, 2050 CBD vision) without jeopardizing other SDGs. Thanks to BES-SIM, models were ready and needed to go from exploratory to target-seeking scenarios. Methods available in Leclere et al 2018. Main results: bending the curve (as affected by habitat conversion only) could be within reach, but we need bolder conservation efforts. However, only additional actions addressing the drivers of habitat loss will allow bending the curve by 2050 while converging towards other SDGs. The study provides new results for GBO-5, and ideas on long-term strategy for production of nature futures scenarios.

### Speed-talks on relevant developments in existing models

- IAMs (Detlef van Vuuren): The link between IAMs and BES models can and should be further improved. The project on post-2020 futures provides a good opportunity; in context it is important to note that some scenarios are already close to nature futures visions (e.g. the work led by Marcel Kok at PBL; or some scenarios derived from the SSPs). Maybe even more important are solution-oriented scenario projects as we are pursuing in the IMAGE project (e.g. SIM4NEXUS or the different scenarios to meet 1.5 degree target, paper from van Vuuren et al, 2018). With respect to the SSPs it is important to note that SSPs can be easily broadened beyond climate (and this was actually intended). Many of the complications related to scenario work for biodiversity also exists for climate. For instance, issues related to bridging across scales, non-linearity and how to deal with feedbacks. One issue is also possible updates in SSPs. For instance, current population projections made by UN are somewhat higher than those of the SSPs. The SSP scenario literature is rapidly developing – already hundreds of papers have been published in many different areas: mitigation, agriculture impacts, water, governance. It is therefore attractive to jump on this moving train – although one needs

to identify how best align specific questions with the SSPs. The Scenario Forum (held in 2019 in Denver but planned to be done every 2 years) is a forum we could use for discussion on such issues across scenario communities. Long term ambitions: new generation SSPs which include feedbacks, multi-scale understanding and computational resolution. A key aspect is that elements should be as much as possible open access (or even source): model assumptions and results, but also key tools such as the land-harmonisation tool. These need to be based on community-based efforts rather than being dependent on single research institute.

- MAgPIE 4 (Florian Humpenoder): is a modular, open-source framework for modelling global land systems and minimizing global production costs, based on optimization, global resolution on 3 spatial layers, and balancing of biophysical and economic aspects. Our work with biodiversity initiatives include the IPBES expert group on scenarios and models, which has initiated the Nature Futures scenario exercise, the ISIMIP project, which has begun work on adding biodiversity to the SSP scenarios framework, the 'bending the curve' initiative, which was initiated by IIASA and WWF, and GEOBON, which has started work on modelling Essential Biodiversity Variables.

## Day 2

### Speed-talks on relevant developments in existing models

- AIM (Tomoko Hasegawa and Haruka Ohashi): aims to estimate bioenergy potential. Outputs: environmental protection map based on current protected areas, biodiversity-sensitive areas, severely degraded land. Global bioenergy potential while protecting environment under different scenarios. This study highlights the importance of policy combinations of balancing multiple goals. AIM-Biodiversity is based on species distribution modelling. Uses a combination of land use and climate change (RCP and SSP1-5) scenarios. Stringent GHG mitigation can bring a net benefit to global biodiversity even if land-based mitigation is adopted. Difference in loss and gain of suitable habitat among SSPs was also significant.
- GLOBIO 4 (Aafke Schipper): global multi-pressure model for local biodiversity intactness (expressed by MSA metric) and several ecosystem services, covering terrestrial and freshwater systems. Updated to higher spatial resolution and updated pressure-impact relationships for terrestrial biodiversity/MSA (climate change, nitrogen deposition, land use, habitat fragmentation, road disturbance, hunting). The BES-SIM results will make model code publicly available. In all BES-SIM scenarios, decrease in biodiversity on average. Efforts being made to develop a species-based approach (complementary to INSIGHTS): 1) integration of land use and hunting in habitat models for tropical mammals; 2) effects of climate change and dams on extent and connectivity of freshwater fish species ranges. Also new post-2020 scenarios realising multiple SDGs, two alternative strategies for conserving nature (Half Earth, Whole Earth).
- INSIGHTS (Carlo Rondinini): integrated scenarios of global habitat for terrestrial species. Rondinini & Visconti 2015; Visconti et al 2016. Includes: 1) Scenarios for invasive alien mammals (maps with vulnerability to spread of alien mammals); 2) analysis of effect of climate mitigation through bioenergy and habitat for birds and mammals (1000 birds, 5000 mammals); 3) agricultural development and habitat available to terrestrial vertebrates (strategies: closing crop yield, healthier diets, reducing food waste, plan agricultural land use to minimize biodiversity decline).
- InVEST (Justin Johnson): 20 ecosystem service models. 1) Now succeeded in global runs of the model, and also just finished: carbon storage, crop production, water yield, sediment regulation, soil health, phosphorus retention. 2) InVEST linked with Global Trade Analysis Project (GTAP). How does change in ecosystem services filter back to changes in macro economy? E.g., effect of lost pollinator habitat ~75 billion in SSP3 (2010 USD). 3) Spatial Economic Allocation Landscape Simulator (SEALS) downscaling coarse projection of change to high resolution; incorporates conservation interventions,

empirically calibrated, linkage with economic and ecosystem service models. This created high resolution land use land cover scenarios with optimized conservation actions.

- PREDICTS (Samantha Hill): measuring site-level biodiversity (species info and land use, human population, accessibility from cities, time since conversion, etc.) providing 4 million freely available data points. Taxonomic coverage of 52,000 species. Uses Biodiversity Intactness Index as indicator. Recent work: 1) forest changes (incl plantation forests) based on remote-sensed data. Overlay with range rarity to look at intersection of forest biodiversity significance and forest biodiversity intactness; 2) comparison of plantation types (e.g. for cocoa: monoculture, restoration, and agroforestry comparison, age) looking at restoration in different ways (over time, and time since conversion); 3) finer scale to be updated with plantation crop-specific data (1km, annual, 2000-2012); 4) freshwater (Van Soesbergen et al.); 5) Uncertainty, scale, time series, regional projections.
- DGVM LPJ-GUESS (Almut Arneth): simulates ecosystem response to land use change, CO<sub>2</sub>, climate change, crop & forest 'enabled'. Coupling LPJ-GUESS to PLUM to explore socio ecological systems in fine spatial detail and process-based; link with agent-based models of land use decision making; adopted own harmonisation to be more independent from IAM/LUH timing. Have to think a bit more about evaluating models against data. This was done with historic FAO data for crops, for SSPs (Alexander et al., GCB, 2017). Also looked at changes in ecosystem service indicators to 2100 (SSP1-5) modelling CO<sub>2</sub> emissions, runoff, N loss, hotspot areas and vegetation. With PLUM, sampled different parameters with normative scenarios (meet 2050 food demand, planetary boundary cropland at 15%, and very conservative additional bioenergy supply).
- Remarks:
  - Looking at most of these outcomes, the main narrative is still biodiversity decline. The big discussion in the literature right now, is that some aspects are declining but others are not. This seems to be missing in our models so we need to consider assumptions and dynamics together. Do the models reflect what is empirically observed? We must take this into account in discussions.
  - Remote contribution (Jan Kuiper): there is a community of freshwater ecosystem modellers - AEMON - who are not engaged with the GBO and IPBES processes. However, considering that freshwater systems, like wetlands, are still underrepresented in Global Assessments where most focus is on land and marine, AEMON could potentially be of importance. So far they have been good in model intercomparison and ensemble modelling, however they mostly focus on specific drivers (e.g. nutrient loading, climate) and have not really connected with integrated scenarios like the SSP's, let alone Nature Futures. It may be good to invite a freshwater modeller representative for one of the coming workshops or potentially organize a Freshwater Modelling IPBES Nature Futures workshop in the future.

### DAY 3

#### Speed-talks on relevant developments in existing models/initiatives

- Fish-MIP (William Cheung): modelling future seafood sustainability under scenarios of climate change and socio-economic development. Differs from other Fish-MIP models as it has specific species data. 1) Looks at marine species richness change under climate change. Links to changes in fisheries catch and implications for human nutrition. Extending into various ocean sustainable pathways, in different dimensions of metrics (social, ecological and economic goals set in 'solution triangle' to optimize their achievement). Also linked to ocean-IAM which includes direct and indirect drivers (e.g. subsidies, trade); 2) Looks at SSPs under different climate regimes; also for specific (sub-)regions, to see if they can meet development goals; 3) Looks at futures of high seas fish stocks and fisheries for countries in different income groups. Opportunities to link with nature futures and other terrestrial BES work.

- Madingley (Mike Harfoot): models spatial ecosystem dynamics based on a cohort based approach of terrestrial and marine animals (adult/juvenile/current body mass, abundance); their cohort dynamics (e.g. metabolism, predation, eating) leading to ecosystem structure and function. Historical reconstructions and future projections as part of BES-SIM exercise. 1) Looking at time series of ecosystem change through time, total abundance declining significantly from 1900s, with total biomass declining similarly, also with some subtle increases. 2) time series of functional richness decline, but also functional turnover increase. Future work is to incorporate feedbacks: biodiversity-ecosystem function relationships (functional diversity and nutrient cycling) and service provision (pollination, pest control, seed dispersal).
- Naturemap (Piero Visconti): Aiming to make biodiversity part of climate solution. Shows synergies and trade-offs in restoring soil carbon and biodiversity. First part connects species distribution data. Also forest management from ground observations on management practice. The extent of suitable habitat uses forest maps and databases for improved species distribution. For above-ground carbon maps, independent data is synthesized into an improved map. Soil carbon uses biomass carbon data completed by assessment of data on soil carbon stocks susceptible to change. From this, areas significant for nature conservation are identified. Preliminary results show areas of significance for biodiversity conservation and climate mitigation. Aichi+SSP2 scenarios optimizes conservation and restoration by minimizing future loss of mammals to see how many we can save (used IMAGE and SSPs). Half Earth SSP2 scenario shows massive shortfall in cropland and pasture. The take-home is that we can suggest very ambitious policies, but need to test against supply-demand of food in trade.
- Regime shift database (Garry Peterson): Some ecosystems or socio-ecological systems can exist in alternative configurations in the same place. As environmental conditions change, e.g. change in rainfall, or there is a shock e.g. a flood, the system can shift from one regime to another. Regime shifts are important because they produce large impacts on ecosystems and people, are difficult to predict in theory and practice, and are persistent. Regimeshifts.org is an open database with 30 types of regime shifts, both earth system as well as local ones. It identifies drivers, location, and ecosystem services impacted by regime shifts. Additions are welcome, especially socio-ecological ones from urban areas. Most entries are 10-30 pages of synthesis, with short and long form. We have published a number of papers on the database, paper describing the database is: Biggs, R., G. D. Peterson, and J. C. Rocha. 2018. The Regime Shifts Database: a framework for analyzing regime shifts in social-ecological systems. *Ecology and Society* 23(3):9. <https://doi.org/10.5751/ES-10264-230309>
- Teleconnections (Henrique Pereira): input-output with biodiversity impact, land use based activities. Results suggest: in western Europe, north America, in reality biodiversity impacts are decreasing and ecosystems are recovering there. Starts to seem an emerging story there, maybe there are areas where things are improving. The other thing they did: all regions of the world impacts decreasing per unit GDP, but doesn't compensate for population and economic growth. No full decoupling yet on biodiversity. Is it because Europe and US displace impact? (...) (Marques et al 2019 Eco Evo) Structure of impacts are changing: Asia-Pacific and Middle East growing as driving impacts in other parts of the world. Significant change in who have shares in the impact in the world. 1) if you want to tax biodiversity impact of trade not look at impact biodiversity but consider trade-off social impact as well. 2) teleconnections, not look only at just trade as it is now, but also accumulated emissions per / capita, western world still way ahead of China. So not just look at current trend at one moment in time.
- Discussions/remarks on the speed-talks:
  - What is Half Earth? Doesn't have to lock people out of nature, can be sustainable use. We assume no harvest, no land-use change, which will not be reality. Major challenge is to be more realistic in what protected areas mean. Often it is not lock out, but this is not incorporated in our models yet.
  - Big risk in model assumptions on lock-out. Also extremely vulnerable areas are not assigned as significant, so is there a bias in the model? We need more nuance in the

way we look at biodiversity (non-attractive species can also be fundamental). This is constrained by data availability but we should not base models on popularity only.

- You use criteria for threat from the IUCN Red List. That cannot go beyond their status no matter the conservation efforts, as restored habitat is needed. So even with Half Earth you cannot cover their distributions? Surprising how little difference there is between Half Earth and Aichi in terms of species conservation.
- How to do these models across scales, and how to include consumption/production perspectives? This would be important for nature futures. The BES-SIM paper shows significant variation between models in projections of local species richness change. Need to discuss this. The iDiv model shows local increase in species richness, but global decrease. Species are colonizing habitats that are being opened up. Biodiversity change may be more complex than what we are representing in our models. The Essential Biodiversity Variables in the GEO BON data portal show biodiversity increase in Europe since the beginning of the 20th century.
- Species extinction, population declines, species richness is horribly insensitive to biodiversity. So are we modelling the wrong indicators? The discussion has been on the role of species richness in maintaining ecosystem functioning, but we have to tell a richer story that connects with real world discussions. If our models just paint the same picture as land cover change, that misses the discussions on biodiversity.
- When we use our common sense, does Europe as a whole have more species compared to 1910? Results apply only for birds or mammals. Very local species richness might be higher (e.g. in city parks), but around them are green deserts.
- We should not confuse species richness with richness of certain species. We need to reduce oversimplification and include complex global system, e.g. teleconnections.
- Main point: getting a richer story of biodiversity change. Key is stronger stakeholder dialogue with end users, what they need, how our work is interpreted, and understood. Different preferences in the most important indicators.

# Annex 4. Breakout group notes from DAY 1

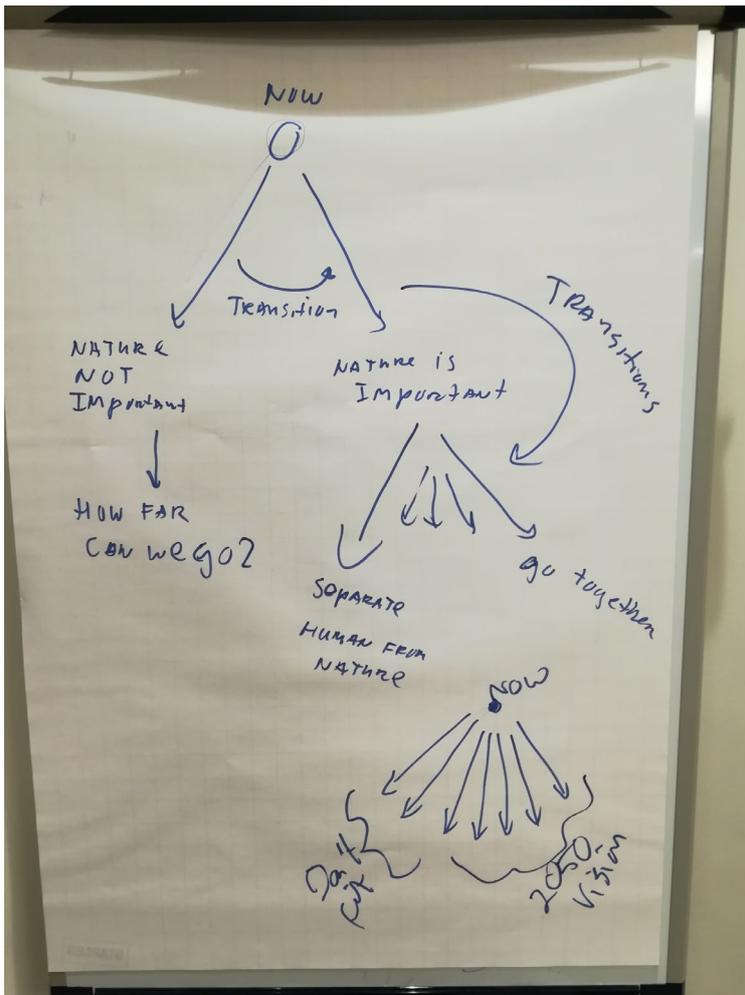
## Group 1. Inputs to GBO-5

*Participants: Tim Hirsch, Rob Alkemade, Carolyn Lundquist, Paul Leadley, Ghassen Halouani (note-taking), Chimere Diaw, Marcel Kok, Sam Hill, David Leclere, Tomoko Hasegawa, Elke Stehfest, Yunne Shin*

Objective of the group: discussing the GBO-5 Working draft for CBD: “*Realizing the vision: Nature and our Future, the fifth global biodiversity outlook*” to build the narrative and make clear pathways.

### **Main topics:**

- What are the key transitions to achieve a better future:
  - Bold conservation effort
  - The land and forest transition
  - The sustainable agriculture transition
  - The sustainable Food transition
  - The sustainable Fisheries transition
  - The sustainable Cities transition
  - The sustainable Freshwater transition
  - The sustainable climate action transition
- Interpreting the vision: what does “living in harmony with nature” look like?
- Pathways to the vision: “it’s not too late to get there”!
- The group discussed the need to add more transitions for a better future:
  - Chimère proposed to consider the “Industrial sustainable transition”, since the issue is also of production not only consumption.
- The group highlighted the fact that it is easier to get the sustainability when all the transitions are done together.
  - For each transition, it is important to take into consideration the dependencies and contributions on the other transitions.
  - It is important to define key transitions and address area of actions.
- Importance of alternative vision of nature vision and how to reach 2050 vision?
- What’s missing from the global assessment? (most important global assessment post paper?)
- Bold conservation efforts need to be combined to major transformations in the way we produce and consume food to prevent negative impact on food and security and to reduce pressure on biodiversity to realize 2050 vision
- How far we would like to go in the GBO-5 beyond the scenarios to realize 2050 vision? (bending the curve and changing the “game” (e.g. how the system works) )
- Harmonize the language: transformative changes vs transitions (“transformative changes” are a whole agenda however “transition” is going from A to B)



## Group 2. Protocol for mid-term exercise

**[First session 13:00-15:00]**

*Participants: Laetitia Navarro, Henrique Pereira, Justin Johnson, Tyler Eddie, Thomas Hickler, Brian Miller (note-taking), Haruka Ohashi*

### Background and Overview

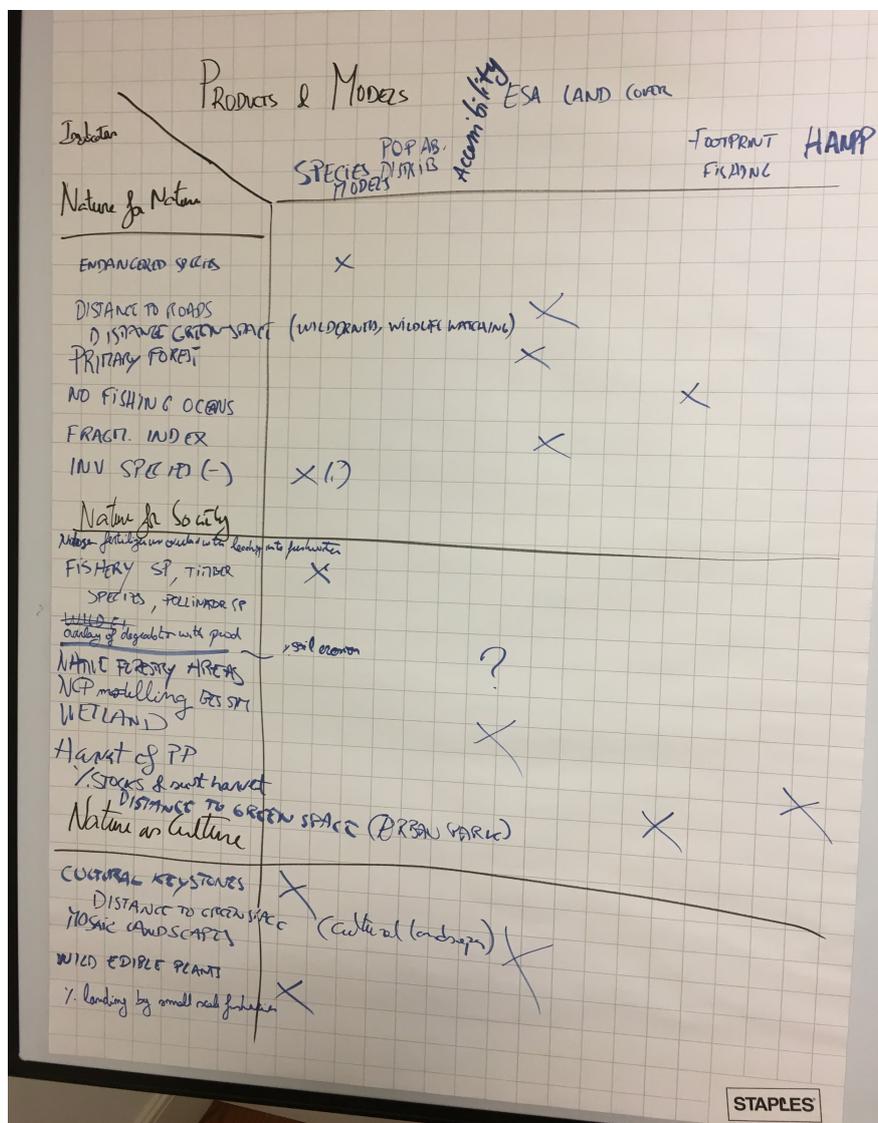
- Goals of this breakout group:
  - Get on the same page about Nature Futures Framework (NFF)
  - If you want to map trajectories (from past to present, initially) in the NFF space in a spatially explicit way, how would you do it?
    - BES-SIM used harmonized land use and indicators for biodiversity and a few for nature contributions to people (provision and regulating), but didn't have much nature as culture
- Review of outcomes from Vancouver meeting (Henrique)
  - Discussed Nature Futures (NF) and developed draft manuscript
  - Plot present conditions in 3D space and improvement expands through time, but there are constraints on expansion (trade-offs)
  - Pareto frontier: trade-offs among different NF (e.g., Nature for Nature, Nature as Society), but going forward in time you can make improvements across all three dimensions (i.e., not constrained to trade-offs)

- Could also look at how a single policy might score on each of the 3 NF
- Developed modelling framework of linking from indirect drivers to direct drivers to EBVs to impacts on society (and feedbacks), and conceptual framework of how to connect land and oceans
- Identified relevant variables and indicators
- *For each pixel, country, region, and globally, could you represent trajectories in 3D NF space? What would it take to do this?*
- *How do we model EBVs and social indicators so we can know how state of nature has changed over time in the 3D space?*
- Can think of each NF (corners of triangle) having a set of policies for drivers and could see outcomes of different combinations. Another way to look at NF is that they're a way to evaluate different policies (score them according to triangle) (i.e., policy-by-policy). Which is most useful and feasible? Second approach could evaluate innumerable policies, so might be intractable
- To find if NF are possible using IAMs, need to find trajectories for drivers to make it feasible to achieve a given future
- Assuming that futures are positive (starting low in all axes), but no optimum (they are normative)
- Any given location could go toward an extreme, but at global level, the state space is more constrained
- Could look at mismatch between reality and idealized NFs
- How do you convert numerous metrics into a single axis (e.g., many aspects of ecosystem services -> Nature for Society)?
- Challenge (esp. with nature for society metrics): Increasing amount of harvest (e.g., fish, HPP) could look like a benefit for society, unless you are moving toward a threshold or is otherwise unsustainable (fisheries alternative: Percentage of stocks at sustainable harvest)
  - Can't just plot where there is ecosystem service provision because its value is dependent on how many people it is serving; new metric= the percentage of need of service that is met by ecosystem
    - See new (yet to be published) InVEST runs

### **Products and Models (see photo of flipchart, which summarizes following text)**

- Species Distributions
  - How do look at the extent of species ranges over 25-30 years?
    - Nature for society: Fisheries species
    - Nature for nature: Endangered species
    - Nature for culture: those important for livelihoods and cultural keystones
      - Culturally important species: At regional level seen conservation efforts focus on specific species, often for cultural reasons – could these serve as an indicator for nature as culture?
- *ESA Land cover*
  - *Nature for nature: distance to roads, primary forest, fragmentation index, polygon size of protected areas, invasive species (but there's an influence of improved detection)*
  - *Nature for society: Native vs non-native (can do this with remote sensing? For Europe but otherwise missing); wetland area (any global product?)*
  - *Nature as culture: mosaic landscapes*

- Footprint of fishing
  - Nature for nature: no-fishing zones
- Human-induced net primary productivity
  - Nature for society: harvest of primary productivity, overlaid with global land degradation products (modelled gridded dataset) (set threshold)
  - Accessibility
    - Nature for society: distance to greenspace (e.g., urban parks)
    - Nature as culture: Distance to cultural landscapes
    - Nature for nature: Distance to greenspace (wilderness, wildlife viewing)
- Nature for society: Total fertilizer use (gridded dataset) overlaid with Nitrogen leaching
- Nature for society: Percentage of fish stocks at sustainable harvest
- Nature as culture: percentage of landings (how much you catch and sell) by indigenous fisheries or small-scale fleets



**[Second session 15:30-17:00]**

Participants: Laetitia Navarro, Henrique Pereira, Tyler Eddie, Brian Miller (note-taking), Haruka Ohashi, Samantha Hill

Should specify model or some kind of data (e.g., SDMs: species extents), then build indicators based on that that are dependent on NF (e.g., for species extent endangered species, important fishery species, culturally important species).

Proposed draft structure, where metrics are categorized by **Biodiversity/State** (species populations, community composition, ecosystem structure, ecosystem function), **Society/Benefits** (ecosystem services), **Management** (management equity):

	Species Pops.	Comm. Comp.	Eco. Structure	Eco. Function	Eco. Services	Mgmt. Equity
<i>Nature for Nature</i>	<ul style="list-style-type: none"> <li>Endangered Species</li> <li>Invasive species</li> </ul>		<ul style="list-style-type: none"> <li>Primary forest?</li> <li>Health (or status indicator) of essential habitats (coral, kelp, mangrove, seagrass, etc.)</li> </ul>		Dist. to wildlife...	<ul style="list-style-type: none"> <li>Strict protected areas</li> </ul>
<i>Nature for Society</i>	<ul style="list-style-type: none"> <li>Major fished spp.</li> <li>(Major) timber species</li> </ul>	<ul style="list-style-type: none"> <li>Interactions pollinators</li> </ul>		<ul style="list-style-type: none"> <li>Carbon sequestration</li> <li>Water purification</li> <li>Storm protection</li> </ul>	<ul style="list-style-type: none"> <li>% stocks at sustainable harvest</li> <li>increasing productivity w/o increasing erosion</li> <li>fertilize use without leaching</li> <li>dist. to greenspace</li> </ul>	<ul style="list-style-type: none"> <li>Sustainable use areas</li> </ul>
<i>Nature as Culture</i>	<ul style="list-style-type: none"> <li>Locally culturally important species</li> </ul>		<ul style="list-style-type: none"> <li>% Mosaic landscape</li> </ul>		<ul style="list-style-type: none"> <li>% of locally grown crop</li> <li>% landing by small-scale fishers</li> <li>Sustainable hunting</li> </ul>	<ul style="list-style-type: none"> <li>Comm.-based mgmt. areas</li> </ul>

Notes related to table:

- Should ecosystem services not be a column (because it is only restricted to Nature for Society by definition)?
- Is culture the local scale of "society"? E.g., Are the ecosystem service bullets for nature as culture a local version of those under nature for society?
- Aspects of table would just apply to one NF
- Data needs:
  - Nature as culture: Locally contingent, culturally dependent, and intertwined
  - Nature for society: measurements are focused on society (benefits you obtain from nature, if sustainable)
  - Nature for nature: measurements focused on nature

**Latest organizational structure:**

	Management	State	Benefit
<i>Nature for Nature</i>	<i>Indicator: Protected areas</i> Marine: World Database on Protected Areas - No take Terrestrial: World Database on Protected Areas 1-3	<i>Endangered spp. and habitat</i> M: Endangered species, Coral reef cover T: endangered spp., pristine forest, wetland extent	M: diving sites T: wildlife watching
<i>Nature for Society</i>	<i>Sustainable use areas</i> M: Mgmt effectiveness (country level) T: World Database on Protected Areas 4-6	M: % depleted stocks T: CO <sub>2</sub> sequestration, water purification, soil retention	M: Sustainable fish catch T: Ag production w/o erosion or water pollution, storm protection
<i>Nature as Culture</i>	<i>Comm-based mgmt</i> M: Comm. Based mgmt (country reports) T: World Database on Protected Areas Comm. Based Mgmt.	<i>Cultural keystones</i> M: status of culturally important spp. T: status of culturally important spp., cultural landscapes	<i># Jobs (livelihoods?)</i> M: number of jobs T: local livelihoods

• **Next steps:**

- Connect with Laura and Sylvia on workshop findings; update table accordingly
- Identify datasets that can address each of these elements; ideally spatially-explicit, but could be country-level data

## Group 3. Long term strategy for building nature futures scenarios

*Participants: Carlo Rondinini, William Cheung, HyeJin Kim (note-taking), Aafke Schipper, Almut Arneht, Sana Okayasu, Mark Harfoot, Rovshan Abbasov, Garry Peterson, Florian Humpenoder, Thomas Hickler, Yunne Shin, David Leclere, Tomoko Hasegawa*

**Clarification Q&A**

- time frame is 3 years
- may be able to inform the Nexus assessment (to be completed 2024)
- focused on Nature Futures but also engaging with existing initiatives
- target vs. exploratory scenarios: being flexible in developing value perspective based scenarios in different context
- representing different visions and value perspectives at individual level as well as regional scale
- qualitative vs. quantitative: 1) list visions for nature futures, 2) think of longer term
- translate storylines to quantitative modelling approaches
- ongoing initiatives that could inform and engage with NF
  - PBL scenarios (NN, NS) analysis for GBO5
  - FAO marine fishery modelling
  - IPCC WG work on scenarios
- Drivers that are not currently modelled
- Indigenous and local knowledge

## Topics

- Trade-offs between futures and scale
- Multiscale scenarios and models
- Combining quantitative and qualitative scenarios / translation
- Uncertainties
- Drivers
- Tipping points and non-linearity
- Biosphere and human society feedback
- Modelling synergies
- Time lag between drivers and responses - from policy decisions to implementation and biological responses
- Model evaluation and benchmarking
- Pathways of policies/implementations/actions
- Linkages between systems/domains
- Linkages between biodiversity and social-elements
- Aligning model outputs with policy and public interest - linking existing models for modelling some options of interest, starting with what's possible now

## Discussion on the topics

- BES-SIM extension (Group 2) but potentially covering all elements of DPSIR
- Non-quantitative feedback ones – soft model, architectural ones – identifying areas where we need data
- Multiple model intercomparisons may eventually lead to harmonization of models which then inform future assessments
- Opening up the modelling process to increase the uptake of the scenarios framework
  - Engaging with people who are involved in other initiatives (e.g. ISIMIP climate)
  - it may eventually require some quality control that models can be sensitive to
- SSP/RCP scenarios all give negative futures – is there a need to use them?
- Innovative approaches – positive futures with solutions/pathways
- Drivers – climate change is much steeper than the land use (almost flat, LUH2), it may be worth comparing these two drivers and include excluded ones such as exploitation
- Identify local interventions/initiatives that can be scaled up for informing policy (building on existing evidence)
- Policy options from stakeholders – bridge point for verification – feeding into modelling
- Species on the Move workshop in Africa – cultural perspective
- Land MIP (impact of land use modelling of climate change)
- Socio-ecological scenarios database (SRC) – bringing communities of practice on this
- Linking top down and bottom up scenarios and modelling initiatives
- Engaging platforms/communities outside of the UN system (e.g. Arctic communities without national affiliations or engagement in the formal system)
- Some harmonization/consistency/framework for and across these (e.g. data) will be good.
- Toy model as an analytical and engagement tool
- From land cover change to land use (management, e.g. fertilization use) - feedback to capture with drivers
- Urban area has rich people, there is potential for greening there with intervention options modelled.
- Closing the feedback loop between drivers and biodiversity (e.g. GLOBIOM & BII)
- Feedback and impact should not be confused.

### **List of potential feedbacks to consider**

- There may be much data linkable to human health (water, forests, green, biodiversity) – also literature and research (on mechanisms as well)
- Air pollution and climate change linkage (uncertain with linkages to biodiversity)
- Climate and biodiversity
- Possibly using qualitative soft linking approach in the short term on socioecological feedbacks
- Dam effect in river systems
- Landscape transformation with tourism
- Invasive species and economic impact (models exist as well as the communities)
- Coastal fisheries – nutrient flows with DGVMs, hydrological models, (JRC plans this for the Mediterranean, InVEST soil topography etc, nitrogen and phosphorous)
- Nutrients to human diet (fish farming effect)
- Linking with ISIMIP for feedbacks with other sectoral modelling (there may be an easy way to do this)

### **Collaboration with ISIMIP**

- Harmonized climate (and land) input between ISIMIP (SSP1, SSP5) and BES MIP
- Spatial downscaling at 1km
- ...

### **Uncertainties**

- Systematic exploration of uncertainties on biodiversity impact, as well as within a given scenario
- Feedback and model behavior
- Conceptual uncertainties in modelling framework: missing or embedded
- Assumptions in crop yields not transparent (e.g. in IAMs)
- Transparent assumption documentation in coupled modelling
- Importance of sources of uncertainties
- Different types of uncertainties – parameters, structure, scenarios, linguistic (there are a review paper as well as a methodological technical paper – Yunne)
- Assessing uncertainties for Nature Futures modelling on a combination of policy options
- Uncertainties linking climate, biological, human, etc.
- Feedback selecting single metrics may reduce uncertainties as ensemble modelling increases uncertainties (maybe, maybe not)
- There are trade-offs between different approaches of modelling in terms of different types of uncertainties
- Direct policy relevance at national and local scales is lacking in IPBES - multi-scale optimization with NF

### **Future plans**

- Follow-on of this workshop - dates unknown, likely end 2019 or early 2020
- Sylvia's workshop on nature cultures indicators, together with knowledge and data task force with indigenous and local knowledge, will be in October 2019 (separate from the above)
- Local case studies workshops: Jan with national park (Netherlands), Laura with youth (Brazil) – what would models find useful from participatory scenarios building workshops as output?

# Annex 5. Breakout group notes from DAY 2

## Group 1. Inputs to GBO-5

*Participants: Tim Hirsch, Rob Alkemade, Carolyn Lundquist (note-taking), Ghassen Halouani, Tomoko Hasegawa, Elke Stehfest, Aafke Schipper, Rovshan Abbasov, Justin Johnson, Florian Humpenoder, Paul Leadley, [before lunch only: David Leclere, Marcel Kok ] [after lunch only: Carlo Rondinini and Sam Hill]*

### Review of timeline for GBO5:

- Zero order draft: end of June 2019
- 1st order draft: mid-August, input into main narratives and placeholders for new work
- 2nd order draft - early 2020

Review from Monday - need to clear in chapeau/intro to transitions that it is not just piecemeal of each of the transformations; rather a joint/nexus effort of many of these transitions.

### Key additional model inputs

- **Paul** example of looking at multiple wedges at the same time from Nexus Land-Use (NLU) groups, to be submitted next week - land-based mitigation options to identify optimal mitigation space through reforestation, changing diet, other options. - two indicators on biodiversity intactness as well as food price/production. Win-win combinations of mitigation strategies. Bioenergy typical worst. Reforest and diet better. Best options are a mix of all mitigation options. \*\*biodiversity model does NOT have climate change in it. (big limitation on model predictions). And is not a 'bold conservation effort' ie assumes all forest remains forest
- **Piero** Visconti et al. new work - reported by David Leclere - update on Bending the Curve. Exploring Half and Whole Earth and a 30% Earth. Implications for food security/provisioning/calories/nutrition value. Has Climate change?? (ask Piero).
- PBL plus work Half Earth/Whole Earth with higher and lower climate change (**Marcel**)
- Leonardo di Caprio group - One Earth Climate Model. Published in Springer. 6 components of action required to achieve 1.5C target. <https://www.leonardodicaprio.org/one-earth-climate-model/> (**Paul**)
- Food and land use coalition (Sept). Health, food, fisheries, business. WWF-UK. (**David**)
- Freshwater bending the curve. AEMON. (**David**)
- Another freshwater group at Arrhus suggested by Jan Kuiper in notes above. (**Jan Kuiper**)
- IIASA - freshwater - implications of achieving SDGs in freshwater. Paper by Simon Parkinson (**David** to follow up)
- NEXUS target seeking scenarios with IMAGE, MAgPIE - RABO study. Sustainable transitions (PBL and PIK) SIM for NEXUS (EU funded). (Elke, Florian - should be published)
- Water/land/energy/food/climate Nexus. (**Elke**)

- Not published: Scenarios for Global Land Outlook (GLO2). UNCCD. How useful restoration for climate change, biodiversity etc. Elke to check if anything published in time. (PBL - **Elke, Marcel**)
- InVEST - 3 ecosystem services - SSP analysis as presented by Justin. Should be published in time, relevant to opening narratives. Raw data can be shared plus any reaggregations (Justin). Pollination, water quality/nitrogen retention, coastal vulnerability. List of other services that are done but unclear if will be published. (**Justin**)
- WWF UK - global futures programme. GTAP model - aiming for UNGA 2019. Report prior to peer reviewed (credible institute so possibly can be included, but unlikely to be peer reviewed yet, to be published with WWF). Economic feedback. Forestry, carbon storage. SSP1,3,5 - but all negative. WWF - wants 'positive futures' - ie transformative change scenario. New paper has SSP1,5 (with RCPs but also a transformative change scenario SSP1 downscaled, weight suitability to ES provisioning. (heuristic search, not optimal search). Bends more than SSP1 but haven't run through economic models yet. Increasing ES - so should be better but not sure how much yet. (**Justin, Aafke** to connect in with globio)
- Freshwater fish models - scenario projections. Potential range contractions, response to flow and water temperature at varying temp targets. (**Aafke**)
- Another study on dams/barriers connectivity. Two studies are not yet integrated (**Aafke**)
- FISHMIP - ensemble models - global. Just climate on fish production? (**Tyler**) Paul - rather investigating impacts under different driver scenarios - ask **William, Yunne Shin** re other ocean scenarios. Scenario and data inputs for marine fisheries scenarios are here: <https://www.isimip.org/protocol/#isimip2a>
- NEXUS - food and land-use. Pastor et al., environmental flows ie rivers (**David, Rovshan**)
- Other papers that might be useful - Cabral et al. Costello et al. (sustainable fisheries)
- InSIGHTS - **Carlo** as per this morning presentation. 3 things near/submitted. 1. Invasive terrestrial mammals, all scenarios good for mammal expansion, less so with climate change. 2. Bioenergy and climate mitigation and habitat for birds and mammals. 3. Different scenarios comparing 4 agricultural options (diet, sustainable agriculture etc), one of which does bend the curve - all vertebrates. Business as usual agriculture much worse than all others - assume no increase in agriculture productivity
- General - BES-SIM for IPBES Global assessment. Just LU not too bad with SSP1/RCP2.6 so not as far as bending the curve but a reasonably positive scenario compared to other SSPs. Biodiv/material ES. details now available, only a summary in the IPBES Global Assessment. All groups. Tomoko, Aafke, David, Carlo. All are currently submitted or in review except for the summary paper Henrique is preparing. **Paul** has offered to coordinate drafting a short text summary in the next couple weeks, 1-2 paragraphs. (**all BES-SIM authors** to send manuscripts/abstracts)
- AIM - **Tomoko/Haruka** (as presented this morning)
- Plastics - **Elke**
- IPCC Land use report coming out soon. Land use, but only marginal analysis of biodiversity (Elke)
- PREDICTS - crop specific biodiversity scenarios; restoration scenarios (partner with GLOBIO/PBL), forest management (**Sam**), Nature Map project (**Piero**)
- **Note for wider group to please check list and add if necessary (adding via contact with Tim Hirsch).**
- **Tim to send template for any summary information to be provided to support GBO5.**

## **Input for key messages skeletons/chapeau**

*(note these were initially based on the bending the curve manuscript). Tim requests input from this group as to key messages that could be submitted as a short paper?*

- Need more and better placed Protected Areas, but above 30% presents risk for other land use (Paul - suggested potential high level message).
- High level message re: Role of bioenergy - nexus models say no good, only small contribution. But other models say no bioenergy. AIMs says can do a lot - so bioenergy is not having a clear message on how much bioenergy you can do (from none to a lot depending on model).
- High level message - need a range of mitigation options done concurrently. And lots of options that can be win-wins.
- High level message - context-specificity of mitigation options, differences between countries, geographies, political/social/cultural context. Chimere discussion eg on relevant trajectories in Africa.

## **Post-lunch break**

- Input for key messages
- Bending the curve only models limited drivers - land use only. Not climate change, invasive species etc.
- Suggest use statement from IPBES Global assessment of key drivers of biodiversity loss/threats to biodiversity.
- Climate mitigation is key. And don't do it using too much land as you run out of land for biodiversity.
- Expanding conservation by standard tools eg Protected Areas is not enough. Just results in displacement effort to somewhere else. And we don't have enough space to do food security etc as well as enough land for biodiversity conservation. Half Earth = protects species but conflict with food security. Also - Half Earth model = impacts on food security.
- Key messages with first version based on a submitted Leclere et al. paper on Bending the Curve
- Few models have Land Use and Climate Change. Need models that address all drivers.
- Bioenergy consequences - context-specific impact based on where it is placed and reduction in other drivers. Can be bad if placed in wrong place where large impacts on biodiversity. Need to be located optimally, but likely that bioenergy is placed optimally could have positive effects on biodiversity.
- Climate message also that PAs will be in the wrong place with Climate Change.

## **Key high level messages (draft, word-smithed within breakout group)**

1. A scaling up of conservation efforts, combining major increases in the extent and effectiveness of protected areas, with large-scale restoration of degraded habitats, and much better protection of nature across farmed or built-up landscapes, is a necessary but not sufficient condition to reverse current trends of terrestrial biodiversity loss. [see 'Bold conservation efforts' transition]
2. Climate mitigation is key to all the rest, and the consequences of large scale use of bioenergy need to be taken into account (see sustainable climate action transition)..
3. Additional steps also necessary to address all direct drivers of biodiversity loss including invasive alien species, overexploitation and pollution, and their interactions with climate change {support IPBES GA - scenarios with LU and other drivers}.

4. Additional conservation efforts (and addressing other drivers) need to be combined with major transformations in the way we produce and consume food, both to prevent negative impacts on food security and to reduce underlying pressures on biodiversity-rich habitats.
5. The combination of changes required to reach a set of outcomes consistent with the 2050 vision includes producing food in a way that results in fewer negative impacts on the environment (both local impacts and drivers of new conversion) [see sustainable farming and land and forest transitions below]; and limiting the demand for agricultural production by adopting healthier diets and reducing food waste [see sustainable food transition] [NB need to add something increased agricultural trade here based on Leclere et al., to be nuanced based on further discussion].
6. The combination of more sustainable agricultural production and food consumption with bold, scaled up conservation efforts will benefit a wide range of goals on sustainable development, including improved human health, reducing the scale of climate change [see sustainable climate action transition] and improving the provision of clean water [see sustainable freshwater transition], as well as providing a realistic path towards realizing the 2050 vision.
7. Synergies of food production/consumption and conservation actions can also be win wins for human health, climate change mitigation and clean water provision as well as providing a realistic path towards realizing the 2050 vision.

## Group 2. Protocol for mid-term exercise long term strategy for building nature futures scenarios

*Participants: former Groups 2 + 3 merged, note-taking by HyeJin Kim and Brian Miller*

[MORNING SESSION]

### **Group 2 Recap and Discussion**

- Full development of NF expected to go beyond 2020
- In the short-term, wanted to explore if we can use existing data to look at how the world has evolved (recently) according to three NF
- If you look at the way the indicators for COP, CBD represent Aichi targets, there's very little for Nature as Culture perspective, and in modelling community
- Even the other NF, need to consider indicators
- If want to evaluate everywhere in the world according to 3 NF, and plot those changes over time, what indicators and data would we need?
- Need indicators that are well-suited for each of the 3 NF: management, state, benefit (columns)
- Also need those that are relevant to marine and terrestrial (within each cell)

### **Questions/Concerns (and responses as sub-bullets):**

- Be careful not to set biodiversity and benefits against one another (e.g., Bernardo Strazburg's (sp?) work – can be mutual benefits)
  - Just want to know what direction each location in planet is going in – we're building a set of tools that allow us to evaluate all dimensions. Also, the trade-offs are really at the corners of the triangle, but there are gradients among them
  - Would want to measure all indicators, because they are not scenarios, and not exclusive

- Be careful with nature as culture, particularly with emphasis on jobs (e.g., don't want to say we'll cut down a sacred forest, but give you jobs so it's ok)
- What's the use of this? To track trajectory? Identifying what's "good" in a given location?
  - Locally contingent, and non-prescriptive
  - There are indicators that are cross-cutting, but the NF have different emphases
- Look at validity of archetypes (NF). The dominant historical paradigm of nature for society is not included here.
  - These are positive futures
- Risk losing efficiency if doesn't connect with SSPs?
  - But the point is that we need new projections of economy and demography to move beyond SSP
  - There's a trade-off – NF are true to the stories that we want to tell, but at the cost of efficiency
  - At local scale, may not need IAMs

### **Overall conclusions/recommendations on the use of NF**

- Need to be careful to articulate the context of NFF
  - Trade-offs among NF is not the important thing – in most cases, there aren't trade-offs and you're looking for improvements and what those improvements emphasize
- Simon: set of indicators and underlying models that capture the full range of world views inherent in NF, that can be used in 3 main ways: 1) Status and historical trends of indicators; 2) inform group 1's work on GBO and post-2020 deliberations (look at how policies would fall relative to NF); 3) recognize the pluralism of how people value nature and pro-actively start formulating scenarios of policy and management interventions that could achieve good outcomes across all 3
- Laura's suggestions for uses of NFF: 1) identifying radical futures and transformation with diverse participants and diverse world-views; 2) look at how different indicators can be framed differently, depending on which value set (NF) you're applying; 3) bridge bottom-up, local stories to global perspective

### **Moving forward**

Needs and suggestions:

- Look at indicators to see how existing work can tie in to NFF and where work needs to go
- How to bridge the divide of assessing biocultural values within these models – maybe look at "seeds" and success stories
- Need to refer to anthropological literature on nature as culture
- Need to include transformative changes that haven't yet been observed, and diverse perspectives
- Need to explore differences in NFF at local vs global scales
  - Assessment has information on scales that HyeJin is starting to collate
- Need to consider feedbacks
  - Building conceptual model might be useful – all NF should have same feedbacks, but the strength of those feedbacks would vary
  - Compiled SE feedbacks in Vancouver and built on that yesterday
- What are indicators?
- How do you model these things?
  - The challenge is that models don't represent plurality and diversity well. How can models explore the diverse space of NFF

[AFTERNOON SESSION]

**Aims for outputs/take-aways at the end of tomorrow:**

1. Guidelines to feed into GBO
2. Roadmap for modeling work of NF scenarios: next workshop, who would be invited, etc.; do we want to do local case studies? Global scenarios? How to incorporate feedbacks? (see topics)

**Topics for discussion/development:**

1. NFF aren't scenarios, need to develop scenarios
2. Socio-ecological feedbacks
3. Linkages between biodiversity and ecosystem function
4. Socio-economic dimensions of biodiversity

**Three tracks:**

1. Local pathways of nature futures (e.g., multi-use) -- e.g., diverse crops leads to more stable yields over time
2. Global modelling of scenarios, where models are coordinated to be comparable
  - a. Drivers
  - b. Scenarios
  - c. Approaches to modelling biodiversity (e.g., community ecology vs. ecosystem ecology)
3. Qualitative scenario development on global scale

**General Discussion:**

- Often a mismatch in scale: e.g., with SSP1 it might be best globally for biodiversity, but can be worst for biodiversity around urban areas (which would expand under that scenario)
- Suggestion: Use case studies to explore different configurations of how scenarios might play out, with consistent variables
  - Suggestion: harness other IPBES task force and working group work (e.g., indicators from Indigenous Knowledge)
- Alternative suggestion: Or should we start with scenarios, can then identify relevant drivers and case studies? In other words, start with desired endpoint and see how we get there? Can use minimum thresholds as cut-off point to define success
- Potential modelling questions:
  - How does diversity affect carbon sequestration? Can simulate stylized scenarios (e.g., reforestation via restoration vs. plantation) and look at outcomes (e.g., carbon sequestration)
  - If you have more agrobiodiversity, what is the impact on food system (stability, distribution of impacts, etc.)?
  - If you manage fisheries in different ways, does it have a positive effect on biodiversity?
  - If you allow for rewilding in agricultural environments, how much biodiversity returns, and what are the implications for ecosystem services?
  - Do protected areas improve biodiversity?
- If all outcomes of NF are good for biodiversity, it just matters what the path is.

## **Brainstorming session on potential modelling questions...**

### Nature for Nature

- Do protected area improve biodiversity?
- Can/does an increase in distribution and or abundance of wildlife create tourism opportunities?
- How protecting 50% of biomes affect biodiversity and ecosystem services?
  - What has been the impact of protected areas on larger landscape biodiversity and people?
  - What the non-terrestrial tools for future conservation?
- How would the rewilding of abandoned agricultural landscape increase biodiversity and allow for sustainable food and timber production elsewhere?
- What is the additional requirements for pressures like climate change to preserve biodiversity once half of the world is protected?
- Is it possible to fulfil the needs for 9.5 billion people on half the land?
- Does nature for nature possibly impact human society?
- What kind of long term forest and environment transition can reduce degradation and deforestation and hasten nature's recovery?
- Can we prevent all species in the ocean from becoming endangered and maintain ecosystem integrity?
- What are the optimal restoration mechanisms in different ecosystems? What are the cost implications in implementing them?
- How to integrate people to nature?
- How can we minimize extinction risks related to global trade?

### Nature for Society

- Can you simulate in IAMs which landscape manages biodiversity better?
- What ecosystem services can be minimized/reduced for conservation – identify over consumption areas and ecosystem service types
- How would transformation to largely plant based consumption affect biodiversity and other ecosystem services?
- How does/will a transition to responsible consumption effect the economy regionally?
- Can we sustainably harvest fish without any species becoming endangered and maintaining ecosystem integrity?
- What kind of ecological / economic development pathways can yield human nature outcomes congruent with all nature based outcomes?
- How would improving biodiversity in agricultural landscape impact the level, resilience, and distribution of ecosystem services?
- What level of resource extraction is sustainable (without degradation)?
- What is the maximum biodiversity value in managed landscapes?
- Does this perspective result in perverse biodiversity outcome?
- Can the ecological pressure be kept low enough in intensive systems to prevent severe feedbacks?

### Nature as Culture

- How would the restoration of traditional diets affect biodiversity and ES?

- How will cultural landscapes (including sacred sites) be affected by climate change and other drivers (e.g.,...)?
- Can we maintain traditional fisheries, maritime cultures, and livelihoods without any species becoming extirpated and maintaining ecosystem integrity?
- How can we model cultural change and how cultural feedbacks shape and are shaped by ecosystems?
- Is land sharing better for biodiversity and human well-being than land sparing?
- How increasing cultural landscapes would improve different aspects of biodiversity and the ES they provide?
- Can the idea of low intensity landscapes be combined with sufficient production for 9.5 billion people?
- Can biocultural thinking identify new global strategies or are all context dependent?
- What kind of societal change can contribute to sustain cultural (traditional) agricultural landscapes (e.g., 'Satoyama')?
- How does close connection between nature and society (increased somehow) affect human well-being?

#### Undecided/cross-cutting

- How would compact cities compare with low density cities on biodiversity locally and globally and ecosystem services?
- How does biodiversity and ES differ in cultural landscape and sustainable intensified landscape?
- What are the conditions when economic development is compatible with nature conservation (what are the tools other than protected areas and CBNRM?)?
- How does having more no-take and sustainable-take areas compared with having sustainable harvest everywhere for livelihoods and biodiversity?
- How can we model pathways nature as support for economies and people (and identify new ways key path)?
- How can we model role of global capital finance in shaping local places?
- What is the role of ownership of land and land tenure/ownership in nature futures?
- Are any of these perspectives incompatible with "desired" growth projections (population, GDP, etc.)?
- How do different perspectives of terrestrial and marine systems impact/feed-back on each other?
- What can we learn for "successes" from each perspective? What enhances? What erodes? Trade-offs, synergies.
- What are the missing drivers of positive ecosystem change for the future (NFF Futures)?
- What are political economies that support each or erode nature future perspective?
- Are the cross-cutting pathways similar for GDP and Human Development Indices (HDI) within the 3 nature future perspectives?
- How much is biodiversity's value and protection costs? In IAMs, all human behaviour is represented by economic mechanism. But price of biodiversity and cost for protection are missing.

#### **Next steps:**

- *Identify which questions are novel and feasible*
- *Figure out how they could be addressed (e.g., IAMs vs. local case studies)*

# Annex 6. Breakout group notes from DAY 3

Priority questions need to be identified. Groups are requested to identify 3 priority questions for each nature futures perspectives, and also to identify the criteria on how to prioritize these. Edits were made live during sessions in a google document.

## Criteria:

- Which are the questions that are novel?
- Which would require small changes in models?
- What one are the low hanging fruit but with high / novel outcomes?
- Which might be best addressed by local case studies or models, and which better with global / regional models. And which perhaps can be addressed on several scales.
- Which ones have the largest potential policy impacts locally/globally.

## Group 1. Nature for Nature

*Participants: William Cheung (facilitation), HyeJin Kim (note-taking), Piero Visconti, David Leclere, Haruka Ohashi, Almut Arneth, Rovshan Abbasov*

1. Under what social-economic context/governance/climate change mitigation would protected area and other area-based conservation measures improve biodiversity and impacts/trade-offs to society in the future?
  - Under what conditions (consistent with SSPs, including transboundary cooperation) would ambitious area-based conservation targets be possible?
  - How protecting 50% of biomes affect biodiversity and ecosystem services?
    - o What has been the impact of protected areas on larger landscape biodiversity and people?
    - o What the non-terrestrial tools for future conservation?

Scale: Limit to global scale

Model: Available to address this question (model intercomparison using a suite of models looking at multiple dimensions of biodiversity)

Policy impact: CBD discussion of targets and goals

2. How would the restoration of abandoned agricultural landscape increase biodiversity and their implications for sustainable food and timber production elsewhere? XxX
  - How ecological corridors around human-managed systems improve biodiversity?

Scale: Global scale and larger regional case studies

Model: In principle, existing models are possible to address this question (vegetation cover/structure linking with species composition and biome shift)

Policy impact: Yes, particularly on restoration vs afforestation and nature-based solutions; also boundary of nature for nature.

3. Would climate change over-ride the positive effects of protected area/other land/ocean policies for biodiversity conservation?

Scale: Local to global

Model: Yes, models are ready to address this question

Policy impact: Relevant to design management of protected area and informing the level of National-Determined Contributions needed.

4. Restoration of ecosystems and effects on biodiversity

- What kind of long term forest and environment transition (restoration of forest) can reduce biodiversity loss and hasten nature's recovery?
- What are the optimal restoration mechanisms in different ecosystems? What are the cost implications in implementing them?
- How would re-introduction of species from zoo affect biodiversity?

Scale: Local to global

Model: Models are available to address the first sub-question, may be for the second, and probably not for the third sub-question

Policy impact: Relevant to restoration-related policies.

5. Can minimizing invasive species, over-exploitation and pollution prevent all species in the world from becoming endangered and maintain ecosystem integrity under projected climate change and population growth?

Scale: Global

Model: Yes, models are available

Policy impact: Yes, for global conservation policies

6. How/whether interventions related to global trade can minimize extinction risks and maintain/restore biodiversity?

Scale: Global

Model: Yes, methods/models are available

Policy impact: A range of effective conservation/trade related policies for biodiversity conservation

7. How to integrate people to nature? → *More 'Nature for society' type question*

8. Do environmental/ecological education improve nature protection?

Scale: Local

Model: Possible qualitative social-ecological model

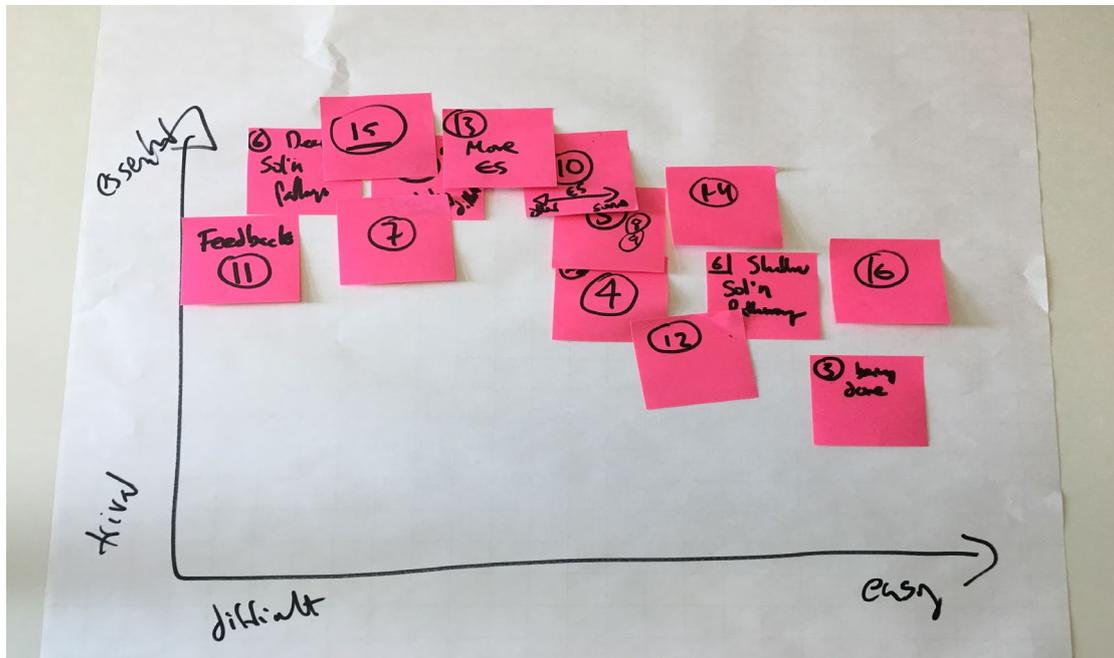
Policy impact: Relevant to local environmental policy

9. Can/does an increase in distribution and or abundance of wildlife create tourism opportunities? → *Seem to fit better to Nature for Society*

10. Is it possible to fulfil the needs for 9.5 billion people on half the land? → *Is it a nature for nature question?*

## Group 2. Nature for Society

Participants: Rob Alkemade, Garry Peterson, Samantha Hill, Detlef van Vuuren, Brian Miller (note-taking), Justin Johnson...



1. Original: Can you simulate in IAMs which landscape manages biodiversity better?
  - a. Revised: Can you incorporate a wide variety of management approaches to enhance ecosystem services (and their ecological implications) into IAMs?
    - i. Rating: Very important, difficult
2. Original: What ecosystem services can be minimized/reduced for conservation – identify over consumption areas and ecosystem service types
  - a. Revised: Trade-offs between ES and biodiversity. How can you find a combination of provisioning services while having enough regulating services?
    - i. DON'T UNDERSTAND
3. Original: How would transformation to largely plant based consumption affect biodiversity and other ecosystem services?
  - i. Rating: Not essential, relatively easy
    1. Driver, and assumes we can model ES
    2. Narrower version of question 4
4. Original: How does/will a transition to responsible consumption effect the economy regionally?
  - a. Revised: How do changes in human behaviour (e.g., consumption) affect the regional economy, ecosystems, and land use, and thus ES?
    - i. Rating: Moderately important, Moderately difficult
      1. There's a subset that is not too difficult
5. Original: Can we sustainably harvest fish without any species becoming endangered and maintaining ecosystem integrity?
  - a. Revised: Can we sustainably harvest fish without any economically important species becoming endangered and maintaining ecosystem integrity such that ES are not compromised?
    - i. Rating: Important, moderately difficult
      1. Some aspects of ES and processes are difficult (?)

6. Original: What kind of ecological / economic development pathways can yield human nature outcomes congruent with all nature based outcomes?
  - a. Revised: How do we define win-win scenarios, including more diverse social-ecological interconnections? And then, how do we identify the pathways to those solutions?
    - i. Deep interconnections: Essential, very difficult
    - ii. Shallow interconnections: Important, relatively easy
7. Original: How would improving biodiversity in agricultural landscape impact the level, resilience, and distribution of ecosystem services?
  - a. Revised: How would improving biodiversity (crops, livestock, wild) in agricultural landscapes impact the level, resilience, and distribution of ecosystem services?
    - i. Rating: Important, difficult
      1. Some aspects (e.g., resilience), geographies, and relationships (wild biodiversity and ag.) very difficult
8. Original: What level of resource extraction is sustainable (without degradation)?
  - a. Revised: See #5
    - i. Rating: See #5
9. Original: What is the maximum biodiversity value in managed landscapes?
10. Original: Does this perspective result in perverse biodiversity outcome?
  - a. Revised: Does managing the world for ES result in changes (increases or declines) in biodiversity, and how does that vary by types of biodiversity?
    - i. Rating: Very important, moderately difficult
      1. Dependent on ES
11. Original: Can the ecological pressure be kept low enough in intensive systems to prevent severe feedbacks?
  - a. Revised: What level of ecological simplification is sustainable, and avoids undesirable human impacts?
    - i. Rating: Important, very difficult

**New Questions:**

12. Can/does an increase in distribution and or abundance of wildlife create tourism opportunities? → *Seem to fit better to Nature for Society*
  - i. Trivial, easy
    1. "How" might be more difficult
13. Expand modelled ecosystem services
  - i. Essential, difficult
14. How do/can ES contribute to the regional economy?
  - i. Very important, relatively easy (if ES known)
15. Same as #4, but focusing on health and other socio-economic aspects (How does/will a transition to responsible consumption effect the economy regionally?).
  - i. Less important (for IPBES), difficult
16. Aquaculture vs wild catch
  - i. Important, not difficult
17. What are the feedbacks, how strong they, and how much do they affect people and other systems?
18. How do we incorporate urban areas and infrastructure into models of biodiversity & ES?
19. Identifying winners and losers at a sub-national level.

## Group 3. Nature as Culture

Participants: Carolyn Lundquist (note-taking), Tyler Eddy, Ghassen Halouani, Aafke Schipper, Paul Leadley

- Priorities based on feasibility, novelty, interest/importance

Scenario	Feasible (1 hard, 10 easy)	Novelty (1 low, 10 high)	Interest/Importance (1 low, 10 high)
<b>Diet:</b> <ul style="list-style-type: none"> <li>• Diversity - maintaining genetic diversity of crops/resilience</li> <li>• Locally sourced - diets/food miles/supply chain</li> <li>• Traditional culture - would maintaining a traditional diet impact biodiversity</li> </ul>	<b>Diversity 4:</b> FAO cropland genetic diversity <b>Local source 6:</b> transport across natural boundaries. Can do local region. Not direct relationship between local supply and GHG footprint <b>Trad'l culture: 1:</b> possibly at very local scale	10	10
<b>Livelihood:</b> <ul style="list-style-type: none"> <li>• Cultural identity maintained (species still exist)</li> <li>• Influence of change/drivers</li> </ul>	Identity: 10 Drivers: 10	5	8
<b>Cultural landscapes and biodiversity</b> <ul style="list-style-type: none"> <li>• Provision of BES</li> <li>• Resilience to drivers/climate change</li> </ul>	Local/regional - been done: 10; global - 2 (how to scale up)	Global - 10; L/R - 5	10
<b>Management intensity</b> <ul style="list-style-type: none"> <li>• Food production efficiency</li> <li>• BES contributions</li> <li>• Land sharing v land sparing</li> <li>• Different types of PAs</li> <li>• Different spatial and temporal management regimes</li> </ul>	Some eg PREDICTS differentiate/GLOBIO but many lump LU: 10	Configuration and link to cultural landscape Global 10 (lots local)	10
<b>Leverage points for restoring and/or maintaining cultural landscapes</b> <ul style="list-style-type: none"> <li>• Eg Ag subsidies for diverse agro-cultural landscapes</li> <li>• PAs that include biocultural (Medellin)</li> </ul>	Ocean models; econometric models - have subsidies - definitely at local/regional (9); Global? (Elke - land taxes in IMAGE?)	5	7
<b>Ecosystem benefits to people</b> <ul style="list-style-type: none"> <li>• Mental health (NfS)</li> <li>• Sense of place/identity</li> </ul>	MH: nature access/distance? 10 (lots of data but not in scenarios) SoP: 2	MH: 8 SoP: 10	MH: 8 SoP: 10
<b>Impacts of greening of urban spaces</b> <ul style="list-style-type: none"> <li>• Accounting for green space on BES</li> </ul>	Right now Urban = low/zero value for biodiv in global miles; local - 10; global - 8	Local - 2 Global - 10	8

- Diet
  - How would diverse and locally sourced diets affect biodiversity and ES? Indicators - biological/cultural/linguistic/agricultural/diet diversity. Key indicator - diversity in agriculture (crops, livestock). Expand LU to build in diversity in crop type in IAMs as well as effects of crop type on biodiversity. PREDICTS is doing with crop management. Measures of genetic diversity of crops (FAO has some info). Localising diets/food miles/supply chain.
  - Maintenance of cultural/social component of diet.
- How will cultural landscapes (including sacred sites) be affected by climate change and other drivers (e.g.,...)? Traditional agricultural landscapes? E.g. landscaped terraces in Papua New Guinea; Satoyama/Japan; ancient Mediterranean cultural landscapes. Drivers: sea level rise, erosion, abandonment, rewilding
- How do traditional fisheries, maritime cultures, [and land-based traditional management] and livelihoods affect biodiversity and ecosystem integrity? [how do we model 'partial' protected areas/traditional land/sea management] How do global change impacts alter traditional fisheries? [without any species becoming extirpated and maintaining ecosystem integrity?]
- How can we model cultural change and how cultural feedbacks shape and are shaped by ecosystems?
- Is land sharing better for biodiversity and human well-being than land sparing? [broader version of 'traditional management']
- How do cultural landscapes affect different aspects of biodiversity and the ES they provide? Do we need to conserve or restore cultural landscapes?
- Can the idea of low intensity landscapes be combined with sufficient production for 9.5 billion people? [management intensity]
- Can biocultural thinking identify new global strategies or are all context dependent? I.e. Scaling up mosaic landscape on a global scale. Linking cultural diversity and biological/genetic diversity. Conceptually - mosaic of multiple LU types at different scales e.g. could be communities each focussed on particular agricultural practice/strain/species. How different cultures react with agriculture/food. (Paul - millet example) More small scale/less intensive agriculture. Is it important to maintain biocultural relationship to improve/maintain biodiversity? Would farm-based selection of crops be improvement vs single crop. Long term resilience though potential reduction in crop yields. Probably larger footprint, less productive. But more resilience.
- What kind of societal change can contribute to sustain cultural (traditional) agricultural landscapes (e.g., 'Satoyama')? Changes in dominant industrial/economic paradigm, IPBES Global Assessment
- How does close connection between nature and society (increased somehow) affect human well-being? Add well-being metrics? E.g. mental health benefits of interaction with nature (NfS though hard to dissociate with NaC?) vs sense of place, identity.
- How do changes in diversity/ecosystem health feed-back on culture - feedback of nature to people. Pastoral plain/organised/managed culture. Like or dislike of open landscapes.
- How useful is rewilding in urban landscapes for biodiversity?

## Group 4. Undecided/cross-cutting

Participants: Henrique Pereira, Carlo Rondinini, Chimere Diaw, Laetitia Navarro, Mike Harfoot, Florian Humpenoder, Sana Okayasu (note-taking) + joining from PM: Tomoko Hasegawa, Piero Visconti

- How would compact cities compare with low density cities on biodiversity locally and globally and ecosystem services?
- How does biodiversity and ES differ in cultural landscape and sustainable intensified landscape?
- What are the conditions when economic development is compatible with nature conservation (what are the tools other than protected areas and CBNRM?)?
- How does having more no-take and sustainable-take areas compared with having sustainable harvest everywhere for livelihoods and biodiversity?
- How can we model pathways nature as support for economies and people (and identify new ways key path)?
- How can we model role of global capital finance in shaping local places?
- What is the role of ownership of land and land tenure/ownership in nature futures?
- Are any of these perspectives incompatible with “desired” growth projections (population, GDP, etc.)?
- How do different perspectives of terrestrial and marine systems impact/feedback on each other?
- What can we learn for “successes” from each perspective? What enhances? What erodes? Trade-offs, synergies.
- What are the missing drivers of positive ecosystem change for the future (NFF Futures)?
- What are political economies that support each or erode nature future perspective?
- Are the pathways similar for GDP and Human Development Indices (HDI) within the 3 nature future perspectives?
- Is it possible to fulfil the needs for 9.5 billion people on half the land? → *Suggested to move from 'nature to nature' to here.*
- How does nature for nature possibly impact human society?
- What would happen if all 3 nature futures co-occur everywhere or if they are done in separate places (segregation)?

Ranking of questions according to **novelty, feasibility, and scale** (global or local) in sheet 1 of the google spreadsheet below (votes of experts shown with X):

		Novelty	Feasibility	Global	Local
1	How would compact cities compare with low density cities on biodiversity locally and globally and ecosystem services?	XX	XXXX	X	XX
2	How does biodiversity and ES differ in cultural landscape and sustainable intensified landscape?	XX	XXXX	X	XXX
3	What are the conditions when economic development is compatible with nature conservation (what are the tools other than protected areas and CBNRM?)?		XX	XX	
4	How does having more no-take and sustainable-take areas compared with having sustainable harvest everywhere for livelihoods and biodiversity?	X	XX	XX	X
5	How can we model pathways nature as support for economies and people (and identify new ways key path)?	XX	X		
6	How can we model role of global capital finance in shaping local places?	XX			XX

7	What is the role of ownership of land and land tenure/ownership in nature futures?	X			XX
8	Are any of these perspectives incompatible with "desired" growth projections (population, GDP, etc.)?	XXX	XX	XXXX	
9	How do different perspectives of terrestrial and marine systems impact/feed-back on each other?	XXXX	XX	XX	X
10	What can we learn for "successes" from each perspective? What enhances? What erodes? Trade-offs, synergies.	XXXX	X		X
11	What are the missing drivers of positive ecosystem change for the future (NFF Futures)?	XXXX	X	X	X
12	What are political economies that support each or erode nature future perspective?	XXXX	X	XXX	
13	Are the pathways similar for GDP and Human Development Indices (HDI) within the 3 nature future perspectives?	XXX		XX	
14	Is it possible to fulfil the needs for 9.5 billion people on half the land?		XXXX	XXX	

Clustering of questions (possible categories):

- Suggested: Equity, Instruments of change, Pathways, Missing drivers
- Sorting trial (in sheet 2 of above google spreadsheets):
  - Aerial based measures
  - Process based solutions
  - Indirect drivers
  - Feedbacks
  - Biodiversity and ES linkages
  - Management
  - State
  - Benefits

<b>Aerial based measures</b>	
4	How does having more no-take and sustainable-take areas compared with having sustainable harvest everywhere for livelihoods and biodiversity?
1	How would compact cities compare with low density cities on biodiversity locally and globally and ecosystem services?
14	Is it possible to fulfil the needs for 9.5 billion people on half the land?
<b>Process based solutions</b>	
2	How does biodiversity and ES differ in cultural landscape and sustainable intensified landscape?
<b>Indirect drivers</b>	
11	What are the missing drivers of positive ecosystem change for the future (NFF Futures)?
8	Are any of these perspectives incompatible with "desired" growth projections (population, GDP, etc.)?
<b>Social-Ecological Feedbacks</b>	
12	What are political economies that support each or erode nature future perspective?
10	What can we learn for "successes" from each perspective? What enhances? What erodes? Trade-offs, synergies.
5	How can we model pathways nature as support for economies and people (and identify new ways key path)?
<b>Biodiversity and ES linkages</b>	

2	How does biodiversity and ES differ in cultural landscape and sustainable intensified landscape?
1	How would compact cities compare with low density cities on biodiversity locally and globally and ecosystem services?
5	How can we model pathways nature as support for economies and people (and identify new ways key path)?
<b>Management</b>	
2	How does biodiversity and ES differ in cultural landscape and sustainable intensified landscape?
4	How does having more no-take and sustainable-take areas compared with having sustainable harvest everywhere for livelihoods and biodiversity?
12	What are political economies that support each or erode nature future perspective?
6	How can we model role of global capital finance in shaping local places?
<b>State</b>	
2	How does biodiversity and ES differ in cultural landscape and sustainable intensified landscape?
4	How does having more no-take and sustainable-take areas compared with having sustainable harvest everywhere for livelihoods and biodiversity?
9	How do different perspectives of terrestrial and marine systems impact/feed-back on each other?
<b>Benefits</b>	
2	How does biodiversity and ES differ in cultural landscape and sustainable intensified landscape?
4	How does having more no-take and sustainable-take areas compared with having sustainable harvest everywhere for livelihoods and biodiversity?
12	What are political economies that support each or erode nature future perspective?

Discussions:

- Feasibility of analysis: most of these questions can be answered using optimisation. But then the question is how to have indicators for certain elements.
- Why is it that most of the highly policy-relevant questions that could provide important answers on development are ranked with low feasibility?

Way forward:

- Novel and feasible: Q8 & Q9
- Feasible and local: Q1 & Q2
- Addressing Q9: How do different perspectives of terrestrial and marine systems impact/feedback on each other? → Possibility of looking into connections identified in the diagram developed in the Vancouver workshop (on land-sea interactions around food)
- Suggestion to go back to the table of the first day and see how to go about modelling each element - or to look at seeds/innovations from the Auckland workshop and consider if they can be modelled