Comment form for 1st Review Phase of Chapter 6 'Linking' of Deliverable 3c) Fast-track methodological assessment on scenarios and models

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Andy Purvis (AP)
Coleen L. Moloney (CM)
Alexey Voinov (AV)
Florian V. Eppink (FE)
Sonja C. Jähnig (SJ)
Jasper Montana (JP)
Audrey Coreau (AC)
Louise Gallagher (LG)
Thomas Brooks (TB)

Nr	Chapter	From page	From line	Till page	Till line	Comment	Reviewer Initials	What was done with the comment
1.		1	16	1	20	As well as compatibility, full integration would ideally bet wo-way, with models and scenarios informing each other: actors' actions will depend on the consequences of earlier actions.	Andy Purvis (AP)	This part of the text was removed
2.		1	30	1	32	…while recognising limitations of and problems caused by standardisation	Andy Purvis (AP)	This part of the text was removed
3.		2	10	2	11	The new version of the Planetary Boundaries framework now also discusses the benefits of considering subglobal scales; it's important to be able to get local and regional understanding as well as global.	Andy Purvis (AP)	Thanks for the suggestion, this is now cited
4.		2	31	2	38	I'd like some discussion of the pros and cons of complex vs simple models. The emphasis in what's written is on complexity, but such frameworks can pile assumptions on assumptions and provide a tenuous chain of evidence at best. Simpler models are also valuable, and I think that should be made explicit.	Andy Purvis (AP)	This is discussed afterwards (end of page 5 / beginning of page 6 as noted by the reviewer two comments below

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5.		2	40	3	3	I don't think this categorisation is especially helpful; d and b are not distinct, and b's wording is poor as it may result from many proceses.	Andy Purvis (AP)	The paragraph was reworked (rearranged and clarified), but we kept it in the draft as we felt it was useful
6.		3	37	3	40	Flip side of point 4 above; now complexity is being talked down too much. I think an important issue is to differentiate between complexity that is justified by evidence and undue complexity.	Andy Purvis (AP)	We modified a sentence at the beginning of page 6 to specify when complexity is detrimental: " These become unhelpful for decision making when error propagation increases uncertainty to an unacceptable level (par. 6.5)"
7.		4	28	4	29	Table 6.1. I cannot see why some cells are empty. Why do scenarios have no two-way coupling, for instance? Do the crosses mean "this is common", "this always happens", or "this is possible"? As it is currently, I don't think the table is helpful at all.	Andy Purvis (AP)	The accompanying text has been expanded and revised to clarify the table contents (second half of page 6)
8.		7	1	7	28	The PREDICTS framework will soon have its first global analysis published: Newbold, Hudson et al. 2015 *Nature* DOI 10.1038/nature14324.	Andy Purvis (AP)	Thanks, citation added
9.		9	15	9	19	Figure 6.2 is impenetrable: very unclear. It needs tob e re-designed or re-thought.	Andy Purvis (AP)	Removed
10.		10	1	12	15	It's hard when a document has many authors, but this section suffers	Andy	The first and

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						particularly from lacking much clear structure. The first three paragraphs largely say the same thing three times. Also, there's no mention of the fact that some response variables are easier to scale than others. E.g., mean local species richness is much easier to upscale than total species richness. Also, very fine scales aren't always of interest – e.g., minute-by-minute changes.	Purvis (AP)	second paragraph have been removed and replaced by a short introductory paragraph, followed by the third para from the previous draft (page 13). The differences in difficulties in scaling different types of variables and their usefulness are now mentioned in the text.
11.		12	1	12	17	Too much emphasis on a single paper from 4 years ago?	Andy Purvis (AP)	We halved the amount of space dedicated to this paper and moved after a wider discussion of the relationship between spatial and temporal scale (page 14)
12.		12	20	14	6	This section comes across much better: even treatment of a range of approaches and case studies, with some nice clear points. However, the sentence on p13, lines 13-14, is impenetrable.	Andy Purvis (AP)	Thanks for point this out, the sentence was dangling and has been removed
13.		14	8	14	20	Temporal scale section is basically empty at the moment. I think it's important, when filling it out, to mention that not all measures are equally temporally responsive (e.g., extinction rate is much less responsive to changes in land management than mean abundance is) meaning that some are better suited than others to modelling and adaptive management on any given temporal scale.	Andy Purvis (AP)	Agreed, section 6.4.1.2 has been completely re-written

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14.		14	21	17	30	I think the organisational scale is perhaps a more important facet than its position in this draft suggests. The social and economical dimensions of biodiversity and ecosystem services will often be the origins of the questions that need to be answered. If ecologists or even conservation biologists decide the agenda, then models and scenarios will tend to stay within the disciplinary comfort zone; in particular, they are likely to be one-way models between drivers and responses, rather than the two-way flow that is needed. I'd therefore favour giving more emphasis to what's in this section. That said, it's obviously still a very early draft.	Andy Purvis (AP)	Thank you for the suggestion, the section has been moved upwards (now 6.4.1.1)
15.		14	21	17	30	An important issue relating to biodiversity scale (and maybe also to spatial and temporal scale) is whether (and when) a high-level approach is better than a bottom-up approach, equally good, or worse. Population ecologists can, in well-studied systems, build exquisitely complex models for single populations (e.g., Soay sheep), but we surely have to hope that that level of detail isn't needed in order to say meaningful things about higher-level diversity trends and patterns. But are there any levels at which modelling can 'ignore' what's going on at a lower level? I think the answer relates to how precise we need our model outputs to be: quantiatively accurate and precise across a wide domain is obviously a lot harder than getting something right on average.	Andy Purvis (AP)	This is an excellent point. We included more text and a new figure (6.5) to stress the existence of an appropriate domain of scales to optimize model predictability.
16.		17	8	17	18	If the tightly-coupled scenarios lose consistency and credibility, doesn't that mean that we don't understand the true coupling between scenario components? Better performance from loose coupling sounds as though it's achieved as a fudge. If that's right, then I'd prefer the text to be more straightforward about it, saying that loose coupling might be better in the short term but that researchers should strive to improve understanding to the point where tight coupling can work.	Andy Purvis (AP)	This paragraph has now been substantially revised. We have clarified that the selection of coupling method is dependent on objectives, policy context and available resources.
17.		21	4	22	21	This section is very apt and nice.	Andy Purvis (AP)	Thank you!.
18.		1	1	22	44	Thank you for the opportunity to read and comment on this first draft of chapter 6: *Linking and harmonizing scenarios and models across scales and*	Coleen L. Moloney	Many thanks for this suggestion.

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						domains. I appreciate the immensity of the task facing the authors and the importance of receiving critical and constructive feedback. My overall impression of the chapter was marred by the difficulty of reading it - I had to go through it a number of times to grasp the main content. In places, I could not understand what information was being imparted. Often, the text pre-supposed knowledge I did not have and the language was very technical. In my comments, I try to concentrate on the overall structure and balance in the chapter. There were numerous small errors in language, layout and some of the detailed content. I have ignored these as instructed(!), assuming they will be corrected in the next draft. In subsequent drafts of the chapter, attention should be paid to the use of simple language and jargon should be avoided. Because this is such a complex topic, it might be useful to shorten the main text and provide more boxes with examples and case studies.	(CM)	Indeed the First Order Draft was a relatively early stage of development of the chapter and suffered from lack of clarity and flow at several points. We hope that the new version is much clearer.
19.		1	1	22	44	The overall structure of the chapter into its sub-headings appeared logical. However, the main sub-headings are all worded in very similar fashion, reducing their effectiveness at guiding the reader through the document.	Coleen L. Moloney (CM)	Thank you for the comments. We have now revised the main sub-heading to reflect the structure of the assessment more clearly. In some subsections, there are parallel topics e.g., upscaling and downscaling. Thus, repeating of those finer sub-headings are inevitable. However, the revised structure more clearly reflects the logical

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								flow to help the reader follow through the document.
20.		4	6	4	14	The aims of the chapter, as listed in this paragraph, do not map well onto the main sub-headings. The first aim (to summarize approaches and initiatives) is addressed in detail in sections 6.2 to 6.4. The second aim (to identify knowledge gaps) is addressed throughout the text, although it is not explicit and there is no summary of the knowledge gaps. The third aim (to discuss relevance to policy-making) was hardly addressed (that I could see); if it was addressed, it was not very clear.	Coleen L. Moloney (CM)	Although we do not have explicit headings on gaps and relevance to policy makers, we decided that it would be more effective to communicate our assessment on these topics when we summarize existing approaches and initiatives. The key messages addressing these three objectives are now clearly expressed in the "Key findings and recommendations" section. We have also revised the text to make sure that we addressed these three objectives (see also the response to the first comment from this referee).

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21.		4	16	4	30	Section 6.2 was very short, mainly listing the different approaches, information that is repeated in Table 6.1. This potentially was an interesting and informative part of the chapter, but most of the required detail is given in subsequent sections (6.3 and 6.4), including examples of the different approaches. Perhaps this section should be amalgamated with the following two sections, retaining only a modified version of Table 6.1	Coleen L. Moloney (CM)	We have now expanded the section and added a new figure (6.2) which sets the scene for the rest of the chapter. While the section is still relatively short , we feel that it provides a concise outline of the structure of the chapter that would help readers navigate the details of the following sections and deserves to be kept separate because it is central to the chapter.
22.		6	1	7	8	Table 6.2 is useful for helping clarify the kinds of models that are being linked, and their purposes. It probably would be difficult to construct an exhaustive list, but there should be an attempt to ensure balance, where possible. Models of terrestrial, freshwater and marine ecosystems are sometimes combined in the rows of the table, but sometimes are separated. For example, the row on "Functional trait models" only has terrestrial examples. In this case, marine functional trait models (e.g. Barton et al. (2010), Science 327, 1509) would require different inputs.	Coleen L. Moloney (CM)	We realize that Table 6.2 needs further work. We have expanded it but we will be only able to finalize it in the final draft as we need coordination with Chapters 3-5. Example of marine trait based models has now added to the table (Barton et

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								al. 2015).
23.		6	1	7	8	Each of the models listed in the Examples column in Table 6.2 should be referenced. For clarity, I wondered if the authors would consider providing more description of each model type – the acronyms and abbreviated text do not convey much information.	Coleen L. Moloney (CM)	We have now referenced all models listed. We will consider the suggestion to add a brief description for each model in the next draft, but this may make the table too large to be printed.
24.		9	7	9	30	The section on the use of multi-dimensional matrices to combine models and scenarios was difficult to understand, and Figure 6.2 did not help! This section needs improved explanations and the reader needs to be guided through the interpretation.	Coleen L. Moloney (CM)	Figure 6.2 is deleted. Instead, we have revised the text to improve clarity.
25.		10	1	14	6	These sections and sub-sections appeared very similar, not really warranting being separated. The section on temporal scales (6.4.1.2) also is much shorter than the one on spatial scales (6.4.1.1.). I did not see a reason to separate the two. My possibly uninformed interpretation was that the sections were mainly about upscaling and downscaling. The descriptions of those processes and the methods used to implement them are informative. It might be useful to use "upscaling" and "downscaling" in the sub-heading, and to amalgamate the text from sub-sections 6.4.1, 6.4.1.1 and 6.4.1.2 into one section. This would also remove some repetition.	Coleen L. Moloney (CM)	The comment of the reviewer is entirely relevant. Although we have now greatly expanded the section on temporal scale, the literature is richer for spatial scaling than for temporal or organizational scaling. Yet we prefer to maintain these topics (spatial, temporal and organizational scales) separated, dealing more in

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								detail with scaling only in the case of spatial scale, and noting that there is a large knowledge gap for temporal and organizational scaling.
26.		11	5	11	28	A figure to illustrate concepts of *grain* and *extent* in terms of space and time (the concepts are initially defined only in terms of space, which is contradicted in the text) might be useful here – perhaps a modification of Figure 6.3?	Coleen L. Moloney (CM)	The concepts of grain and extent are now defined considering spatial, temporal and organizational scales. A new figure was also introduced to facilitate the understanding of how grain and extent change with scaling processes (Figure 6.3).
27.		13	41	14	6	The section on cross-scaling needs more detail. It could possibly be kept separate from descriptions of upscaling and downscaling?	Coleen L. Moloney (CM)	We included more details on this topic and moved it to another section, once cross-scale interactions incorporates spatial, temporal and organizational scales. Also, a box has been added to provide an example of a quantitative method to address

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								the cross-scale issue.
28.		16	1	16	3	There is brief mention here of what might be considered a central and important aspect of considerations of organisational scale: short election/ budget scales versus long human impact/ ecological scales. This is a fundamental issue when one considers the background and context for IPBES, and is related to the third aim of the chapter (relevance to policy-making). Could this aspect be addressed in more detail, focusing on ways to deal with the tension caused by different organisational scales and solutions for decision-makers?	Coleen L. Moloney (CM)	Thank you for the suggestion. We have expanded this section. For example, we now discuss the issues that, to make modelling more relevant to decision making, two distinctions may be useful; 1) model building *with* decision makers and model building *for* decision makers; and 2) discrete models which present an isolated point (often more accurate but narrow) and continuous models which aim to simulate pathways (often more intuitive but comprehensive).
29.		18	1	18	15	Figure 6.4 is difficult to understand. It requires a more detailed caption.	Coleen L. Moloney (CM)	This figure (now Figure 6.6) and caption are revised to improve clarity.
30.		19	31	20	1	Model uncertainty also is caused by uncertainty in the model assumptions (see Platt et al. 1981, Mathematical models in biological oceanography. UNESCO	Coleen L. Moloney	Model assumption as a source of model

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						Press), especially when deciding what to include and exclude from models.	(CM)	uncertainty has now been included in the revised draft. We also referred to Platt et al. (1981) as suggested by the referee.
31.		1				Several comments about the Abstract. I find it quite poorly written. See the file attached.	Alexey Voinov (AV)	Indeed! In reality this was not the abstract but the first version of the key messages. They have now been entirely revised.
32.						There is a large body of literature on model integration, which seems to be left aside in this chapter. I would recommend that the terminology used in the chapter be somewhat synchronized with this literature. An important overview paper is Laniak, G. F., G. Olchin, J. Goodall, A. Voinov, M. Hill, P. Glynn, G. Whelan, et al. 2013. "Integrated Environmental Modeling: A Vision and Roadmap for the Future." *Environmental Modelling & Software* 39 (January): 3–23. doi:10.1016/j.envsoft.2012.09.006. http://linkinghub.elsevier.com/retrieve/pii/S1364815212002381. It's part of a Special Issue on integrated modeling, which also treats many of the very relevant questions for this chapter. For example model 'harmonization' apparently is what is discussed when speaking about ontologies and semantic mediation.	Alexey Voinov (AV)	Thank you for the suggestion. We have now reviewed and incorporated the reference suggested by the referee in the revised draft. In the third author meetings, we have spend time trying to harmonize the definition and topology of models and scenarios across chapters.
33.						Model comparison has little to do with model integration. I would rather talk about model comparison within the context of model characterization. See: Bennett, N.D., B.F.W. Croke, Giorgio Guariso, Joseph H.A. Guillaume, Serena H. Hamilton, Anthony J. Jakeman, Stefano Marsili-Libelli, et al. 2013. "Characterising Performance of Environmental Models." *Environmental Modelling & Software* 40: 1–20. doi:dx.doi.org/10.1016/j.envsoft.2012.09.011.	Alexey Voinov (AV)	We agree with the referee. The role of model comparison in model characterization is now clarified in the

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						http://www.sciencedirect.com/science/article/pii/S1364815212002435. This paper could be also referred to in the context of the 'benchmarking' - p.19.		revised chapter draft. We also reviewed and cited the reference suggested by the referee.
34.						My major concern with this Chapter is very little of critical reflection about the whole task of model linking for biodiversity and ecosystem services.	Alexey Voinov (AV)	We agree this is an important topic. Thus, we invited the referee (Alexey Voinov) to write a paragraph which he kindly did. We have now incorporated.
35.		9				The multi-dimensional matrix method should be better described. I have no idea how it works. There are also no references to explore any further.	Alexey Voinov (AV)	We agree that it was unclear and not well developed, now removed from the draft.
36.		14				Looks like there is not much we have to say about the temporal scale. Should this be identified as a problem area that needs more research?	Alexey Voinov (AV)	The temporal scale paragraph has now been completely rewritten and greatly expanded.
37.		14-16				The whole history of ecosystem services research, starting with the Costanza paper is certainly interesting, but how is it relevant to the topic of this chapter? E.g. how does Table 6.3 help us harmonize across time scales?	Alexey Voinov (AV)	We agree this is an important topic. Thus, we invited the referee (Alexey Voinov) to write a paragraph which he kindly did. We have now incorporated his suggestions in the draft chapter.

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38.		20				Table 3 missing	Alexey Voinov (AV)	It was an editorial error. The original "Table 3" had been removed from the draft. We have corrected this error.
39.		23-26				All the examples are very much focused on the global scale, whereas in my opinion that is exactly the scale that is most problematic for meaningful ecosystem services estimates. Would be nice to provide a more local example as well. Or perhaps discuss why they are so hard to find.	Alexey Voinov (AV)	Thank you for the suggestion, a new local case study has been added (Box 6.4 - Manawatu watershed, New Zealand).
40.						My major concern is that we are in a way ourselves illustrating one of the main problems of model integration. That is lack of a common vocabulary and naming conventions. As I mention in my review, there is a pretty vast literature on model integration, component linking, or coupling, with which we probably need to 'harmonize' our presentation.		We agree. In the third author meetings, we have spend time trying to harmonize the definition and topology of models and scenarios across chapters.
41.	6.0 - 6.5					I would propose that in the revision, careful attention is paid to clear and consistent use of terminology. I will give examples that jumped out at me and leave the rest for a revision.

The text refers to harmonisation as relating to both the integration of separate models and the ability to compare output from different integrated models. I would argue these are entirely different, and that only the latter has a relation to harmonisation. Later on, harmonisation is equated with up and down scaling.

There is very little explanation of what is meant by 'domains'. Does the term refer to the ecologic and social or economic domains, or monetary and non-monetary value domains? | Florian V. Eppink (FE) | Thank you for the suggestion and comments. In preparing the revised chapter draft, we have clarified the use of terminology.

We have clarified the definition of "harmonization" as the process to bring models or scenarios |

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						On page 2 line 7 it is suggested that domains, elements, components can be used interchangeably. Given that apparently chapter 1 defines these terms (which it does not clearly do), then it is surprising not to employ the definitions developed by IPBES consensus. Page 5, lines 5-8 suggest that one-way models are not dynamic. That is simply false, as a model of a unidirectional relation can be specified to incorporate dynamics. Page 13, line 10: "Upscaling consists of (…) from a broad scale to a high resolution scale." A 'broad' scale is not defined and this sections seems to conflate extent and resolution, in the process diminishing the reader's understanding of upscaling. 'Aliasing' then makes a brief and underdeveloped appearance, and the subsequent section (erroneously?) calls the use of multi-scale models 'cross-scaling'.		together, they need to be made compatible or consistent with one another. Based on this definition, scaling falls under "harmonization". In the revised chapter, we made sure that all the discussion about harmonization is consistent with our definition. We have also made sure that the use of terms "domains" and "elements" is consistent with IPBES consensus. To facilitate this, these terms are now defined in a cross-chapter glossary. We agree that one-way coupling can also be dynamic. We have revised our text to correct this. We have also revised the section

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								on scaling to clearly defined and discuss the difference between extent and resolution. We also distinguish the terms multi-scale and cross-scale in our discussion.
42.	6.0 - 6.5					The text contains some tautologies that should be removed. For instance, p5 line 8: "(…) one way coupling (…) is unidirectional." P5, line 39: "State-of-the-art (…) has often not been used."	Florian V. Eppink (FE)	Thank you. These tautologies have been removed.
43.	6.0 - 6.5					I am not aware of IPBES decisions on this topic, but in my view it is vital to separate the concepts of biodiversity and ecosystem functions (and services). The disparity in the weight given to species models and models of ecosystems and their processes seems to support the idea that these are in fact different concepts, at the very least from a data and modelling viewpoint.	Florian V. Eppink (FE)	We agree that these are indeed separate, although biodiversity supports ecosystem services. One of the aims of this chapter is exactly to explore how scenarios and models can be used to make the link explicit between the two.
44.	6.0 - 6.5					I appreciate the difficulty of the following wish, but would it be possible to provide stronger recommendations? The chapter provides detailed discussions of many problems and methods, but I was hoping IPBES would give support to certain approaches. If taken up by the scientific community, the IPBES recommendations might deliver more comparable results in the future, and provide a basis for further synthesis and insights into the problems of and solutions to biodiversity and ecosystem modelling.	Florian V. Eppink (FE)	We agree with the referee. Clearer and stronger recommendations are now made in the revised chapter in the "Key recommendation" section.

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45.	6.3.2					Figure 6.2 and its role in the chapter would benefit from additional clarification	Florian V. Eppink (FE)	In the 2nd order draft, we revised the text to describe and discuss the topic. We decided that Figure 6.2 would not provide additional information from the revised text and therefore removed it from the chapter.
46.		14	43			Costanza et al (1997), even with the defense of that study, should not be given as the only example of value transfer.	Florian V. Eppink (FE)	In the revised draft, more examples are now provided, in addition to Costanza et al. (1997).
47.	642					Scenario development is related, but separate from model development, so it could be a standalone chapter.	Florian V. Eppink (FE)	The structure of the chapter and its scope is defined and agreed by the IPBES plenary. The scope includes both model and scenario. Thus, the author team cannot change that.

Instead, in the revised chapter, we make sure that the key issues that are specific to scenario |

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								development and to model development are discussed separately, while their linkages are also discussed.
48.	651					As suggested above, readers might expect the general ideas in this section to be given more content.	Florian V. Eppink (FE)	We have further substantiated our chapter with content, including updated and new text, figures and tables.
49.	6					Generally, I find that in the whole deliverable aspects related to freswhater are not enough represented, although they provide essential ecosystem services, host an exceptional high proportion of biodiversity (given their coverage) and are under highest threat of all ecosystems.	Sonja C. Jähnig (SJ)	We have now added references on freshwater, as well a freshwater case study (Manawatu watershed, NZ)
50.	6	6				Clearly, freshwater and floodplains aspects are missing, here; given the importance of freshwater ecosystems to humans, I would suggest to add at least freshwater examples, where available, e.g. SWAT models for hydrology, or species distribution models applied in rivers, e.g. (and references therein) - Domisch S, Araújo MB, Bonada N, Pauls SU, Jähnig SC, Haase P. 2013. Modelling distribution in European stream macroinvertebrates under future climates. Global Change Biology 19:752–762. - Jähnig SC, Kuemmerlen M, Kiesel J, Domisch S, Cai Q, Schmalz B, Fohrer N. 2012. Modelling of riverine ecosystems by integrating models: conceptual approach, a case study and research agenda. Journal of Biogeography 39:2253–2263. - Kiesel J, Schröder M, Hering D, Schmalz B, Hörmann G, Jähnig SC, Fohrer N. 2015. Development, sensitivity, and univariate application of the macroinvertebrate community model HET. Fundamental and Applied Limnology (Archiv für Hydrobiologie) 186:117–133. - Kuemmerlen M, Schmalz B, Guse B, Cai Q, Fohrer N, Jähnig SC. 2014.	Sonja C. Jähnig (SJ)	Good suggestion to also include, at least, one example on SDM modelling for freshwater systems. Domisch et al. used the same inputs as commonly used for terrestrial species for macroinvertebrates. As we only can list very few examples, adding this reference wouldn't add very much. The

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						Integrating catchment properties in small scale species distribution models of stream macroinvertebrates. Ecological Modelling 277:77-86.		BIOMOD modelling platform, which has been widely used, is already mentioned in the table. Jähnig et al. review the importance of hydrological variables for modelling the distribution of species in riverine systems and describe one example application. Also Kuemmerlen et al. describe an application, in which hydrological variables were derived from a hydrology model and then used to simulate the distribution of species in a catchment. These latter two references were now included in the text (end of second paragraph after table 6.2), but not in the table

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								because we think that the table should be more general.
51.	6	6				I am not quite sure if this is the best place for this table – it has very valuable information but seems not quite connected to the chapter's topic; many of the lines relate to Chapter 4?	Sonja C. Jähnig (SJ)	The table should demonstrate the links or disconnect between impact models (chapter 4) and ecosystem service models (chapter 5). Therefore, we think it is adequate to have it here.
52.	6.4.1.3.	16				Table 6.3 – the table header seems not to match the content	Sonja C. Jähnig (SJ)	In the revised draft, we have turned Table 6.3 into a Figure (Fig. 6.4), with the appropriate caption.
53.	6.4.2	17				I would find it very important to stress that scenarios are not only the IPCC scenarios - this was misleading in various projects I was involved in! People now tend to think in IPCC-scenario categories ONLY; in that respect the section in Chapter 1.2.4 is broader set.	Sonja C. Jähnig (SJ)	We have clarified that environmental scenarios are not limited to those that are developed by the IPCC. In the revised draft, we have also included other examples, including those from GBO, GEO, MA etc..
54.	6.5.2	21				This seems another chapter that contains information which is already outlined a bit differently in another chapter (4.5) – I would suggest to pull together these aspects into one place, as it seems to confusing to read 1-3 times	Sonja C. Jähnig (SJ)	As we are revising our drafts and working towards

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						about it in the different context.		the final version of the report, we are continuously coordinating with other chapters to minimize overlap and ensure consistency.
56.	6	-	-	-	-	One of the central "key messages" of this chapter is that "We need to build communities of multi-disciplinary researchers and practitioners to harmonize and link across models, scales and domains" (P1L39-40, and this is reiterated in the conclusion P22L35-37). This finding deals explicitly with the human resources and institutions associated with model and scenario work – elements of models and scenarios that have been given limited to no attention elsewhere in the chapter. Presented here as a key finding, it suggests that understanding the nature of the modelling community, its disciplinary mix, the challenges that it faces in integration and communication, and the social, economic and political environment in which it operates is significant for successfully linking and harmonising models and scenarios across domains and scales. The addition of extensive detailed analysis with literature (and identified gaps) on how and why communities of multi-disciplinary researchers need to be built would be required to present this statement as a key finding.	Jasper Montana (JP)	Thank you for your suggestion. We have now substantially revised our Key findings and recommendations. We also explicitly direct our recommendation to the IPBES Task Force on Capacity Building and on Knowledge and Data through which actions relating to human resources and institutions are dealt with.
57.	6	1	10	1	15	The first paragraph should explain why the issue of linking and harmonizing scenarios and models is useful. Moreover, the word "techniques" appears in this paragraph for the first time associated with "knowledge", which is a bit reared at this stage of the document. May be define it?	Audrey Coreau (AC)	We agree. We have now explained more clearly in the first part of the chapter about the importance and reasons for linking and harmonizing

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								models and scenarios. We also referred to other relevant chapter (esp. Ch. 1) where this topic is also discussed. The relevant techniques to link and harmonize models and scenarios is now outlined in Table 6.1.
58.	6	1	41	4	34	General comment: the chapter is written as if it was always useful / necessary to link across scales and domains, or to harmonize scenarios and models (which are 2 different things, I think). However, there are probably some situations / some issues where a single scenario approach at a precise scale is more useful than a complex fully integrative model. Maybe this should be said in introduction. See for instance Halpern et al. 2009. Mainstreaming: a hero of lost causes? Diffusion and transfer of a policy instrument in the European environmental, gender and urban policies.	Audrey Coreau (AC)	We agree. We have clarify the text and highlighted as a key message that "It may not be necessary to explicitly account for all the interconnections such as across scales, or between biodiversity, ecosystem services and human well-being for some decision-making contexts. However, many real-world decisions need to account for these interconnections.

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								Thus, exploring them as well as the associated uncertainty may be desirable."
59.	6	2	12	2	20	I do not understand why there is a precision about the definition of projection compared to scenario at this step of the document. This could be useful in chapter 2?	Audrey Coreau (AC)	We agree. We have now removed the definition while referring it to earlier chapters when needed.
60.	6	2	40	3	4	Models and scenario outputs may differ also because they do not share the same values, or the same worldviews. Moreover exploring the differences between models and scenarios outputs is also a good argument not to link them.	Audrey Coreau (AC)	We agree with the suggestion. We have added this into the revised chapter draft.
61.	6	3	5	3	6	Decision makers may be able to understand and evaluate contradictory outputs, even if they are not scientists… Sometimes they do not want to, or do not have the time to do so, this does not mean that they are unable to understand.	Audrey Coreau (AC)	We agree. The text has been revised and removed the comment about policy makers not able to understand and evaluate contradictory outputs.
62.	6	3	45	4	4	The discussion about the limits of harmonization seems to be a little too short.	Audrey Coreau (AC)	In the revised draft, we have detailed discussion about the limitation of harmonization in the subsequent sub-sections.
63.	6	17	31	18	27	The section on scenario is extremely small compared to the section on models.	Audrey Coreau (AC)	We have expanded this section in the revised chapter.

Nr	Chapter	From page	From line	Till page	Till line	Comment	Reviewer Initials	What was done with the comment
64.	6	19	24	22	21	This section is only on models, not on scenarios.	Audrey Coreau (AC)	It is true. That's because scenario is supposed to be used to explore uncertainty, so the perspective is different from that for models. Therefore, we have removed scenario in the subheading of this section.
65.	6	22	22	22	44	Scenarios are also useful ways to take into account uncertainties and to link between them various scales and dimensions. This could be explained and described with more attention in this chapter, using literature on futures studies. This literature is not specific on environmental issues but can be very useful to understand the strengths and weaknesses of the scenario approaches. See for instance : http://www.sciencedirect.com/science/article/pii/S0016328714000779 http://www.sciencedirect.com/science/article/pii/S0016328713001699 http://www.sciencedirect.com/science/article/pii/S0016328713001195 or Zellmer. 2006. The nature of ecological complexity: a protocol for building the narrative Carpenter. 2002. Ecological futures: building an ecology of the long now Bradshaw and Brochers. 2000. Uncertainty as information: narrowing the science-policy gap Peterson et al. 2003. Uncertainty and the management of multistate ecosystems: an apparently rational route to collapse Swart et al. 2004. The problem of the future: sustainability science and scenario analysis Van der Sluijs. 2005. Uncertainty as a monster in the science-policy interface: four coping strategies	Audrey Coreau (AC)	Thank you for your suggestion. We have now incorporated this in section 6.5.1 and cited some of the suggested references.
66.		General comme				I think the linkages issue is a critical one and I support its treatment as a separate chapter with all the emphasis it is due. Congratulations to the writing	Louise Gallagher	Thank you!

Nr	Chapter	From page	From line	Till page	Till line	Comment	Reviewer Initials	What was done with the comment
		nt				team on producing great, well-written content overall.	(LG)	
67.		1	20	1	25	In the key messages, suggest adding in the 3rd paragraph: To integrate between domains, we need to improve our understanding of the direct and indirect causalities between biodiversity and ecosystem services, as well as between BES and economic and social performance against stated national, sectoral or societal goals. Or something to that effect because in terms of communication on ecosystem services, it is not clear for many people that there is a third step to make the connection between BES and stated goals like the SDGs, national goals on poverty, export targets for agricultural commodities...etc.	Louise Gallagher (LG)	We have substantially revised our key messages. The message suggested by the referee reflected in the first key message. Also, the importance of linking and harmonizing models and scenarios in the context of sustainable development is highlighted in Ch. 1.
68.		1	30	1	30	I agree with the emphasis on indicators and their role in providing or highlighting linkages in the key messages. There is little discussion on the existing indicator systems (stand alone or embedded in existing models) in the body of the text. Will this be an additional chapter or a future publication?	Louise Gallagher (LG)	A discussion on model metric in the context of linking and harmonizing models is now discussed in the revised chapter e.g., in 6.4.3..
69.		11	15	11	20	Given that the level of landscape/biome can be essential to the organisational scale/ management of ecological integrity in conservation practice, considering this scale as part of the a) sub-national level and b) as a specific 4th scale to add to the spatial extents in IPBES might be something to consider.	Louise Gallagher (LG)	While we agree that the level of landscape/biome is relevant to practical conservation, we have now replaced the previous Fig. 6.3 with a new table (6.3) and

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								figure (6.3) that tackle the issue more comprehensively.
70.						In the standardisation of scenarios discussion, there seems to be no explicit discussion of the need for customisation of scenarios for specific decision-situations - either building place-based scenarios or support to interpreting global scenarios, e.g. climate change, to localised contexts. Perhaps there needs to be some reflection on how standardisation can be achieved in a) the processes for how the scenarios re. the 3-4 major modelling themes identified by IPBES in the Deliverable 3c are produced or b) the process by which globalised, continental scale or regional models can be interpreted for the typical decision/management levels, i.e. national and sub-national scales. Or at a minimum, saying something in the text about ensuring that standardisation processes allow flexibility for context?	Louise Gallagher (LG)	Thank you for the suggestion. An expansion on the discussion of this topic is now included in section 6.4.2.
71.	6	1	21			Presumably standardisation of classification schemes and taxonomies is also important here? The classification proposed by Salafsky et al. 2008 Conserv Biol is an important step towards this. For species taxonomy, the quantitative approach proposed by Tobias et al. 2010 Ibis makes a major step forwards here. Broad consensus in classification of ecosystems, and of ecosystem services, remains lacking.	Thomas Brooks (TB)	We have now substantially revised the key messages and this particular one has been removed. It probably sits better in an earlier chapter.
72.	6	2	10	2	11	Does Chapter 6 need to link itself to the planetary boundaries concept? It seems that harmonisation of scenarios and modelling is important for many reasons, regardless of how valid the planetary boundaries concept is. Given that it is contested (e.g., Brook et al. 2013 TREE), I'd recommend dropping this mention of planetary boundaries here.	Thomas Brooks (TB)	We received contrasting reviewer comments on this. For now we decided to keep the updated reference to planetary boundaries (Steffen et al. 2014), with the understanding that it is not a key

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								issue for our chapter either way.
73.	6	2	20			Maybe add "…or extinction risk…" before "…in a region".	Thomas Brooks (TB)	Thanks for this detailed comment, but it is not relevant anymore as the text changed in latest draft.
74.	6	2	31			Move "(multiple organizational scales)" to after "plants", and add "(benefits)" after "people".	Thomas Brooks (TB)	Thanks for this detailed comment, but it is not relevant anymore as the text changed in latest draft.
75.	6	3	39			Extra "complex".	Thomas Brooks (TB)	Thanks for this detailed comment, but it is not relevant anymore as the text changed in latest draft.
76.	6	4	28			Add the point on standardization of classification schemes and taxonomies, noted above, into Table 6.1? Not sure that this fits under "methods" or "metrics".	Thomas Brooks (TB)	Great suggestion, thanks. Done and mentioned in the text afterwards.
77.	6	5	35	5	36	I think that the mention of Chapter 3 here should actually be Chapter 4, and the mention of Chapter 4 should actually be Chapter 5?	Thomas Brooks (TB)	Yes, thanks, corrected.
78.	6	5	36	5	42	Worth reiterating the key point from Chapter 5 that rather few ecosystem service models tackle the "demand side" of ecosystem services, i.e., "realized" or (especially) "essential" ecosystem services (Turner et al. 2012 BioScience).	Thomas Brooks (TB)	Thanks, point made and ref. added.
79.	6					Table 6.2. It would be good to add a genetic example to this, as well as the species and ecosystem ones, to reflect the span of scales of ecological organization encompassed by "biodiversity".	Thomas Brooks (TB)	It is true that modelling global change impacts on genotypes instead of species is an emergent field (e.g.

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								Balint et al. 2011 (Nature Climate Change), but to our knowledge without any explicit consideration of ecosystem services. As we don't aim at covering all modelling techniques in depth here, we would rather omit the genetic level in the table. Such modelling work could be discussed in chapter 4. We now describe the scope of table 6.2 more clearly in the caption of the table.
80.	6					Table 6.2. An important addition here would be a row for extinction risk. Cells for this could be along the lines of: Models = "Extinction risk assessment", Inputs = "Measures of population sizes, trends, and dynamics relative to threshold values", Outputs = "Extinction risk categorization", Examples = "IUCN Red List of Threatened Species", Ecosystem services = "Provisioning, Cultural and Amenity", Examples = "Trends in pollinator extinction risk (Regan et al. 2015 Conserv Lett)". The reference to be added to lines 2–8 would be "IUCN Red List of Threatened Species (Mace et al. 2008 Conserv Biol)".	Thomas Brooks (TB)	The two studies given here describe past trends and not any modelling or scenario work. In the table, we only mention models or frameworks that can be used for scenarios without any very substantial further development. But we will consider

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								incorporating this suggestion in the next draft, with reference to forecasting models and scenarios, e.g. Pearson et al. 2014 Nature Climate Change.
81.	6					Table 6.2. Another important addition here would be a row for identification of important sites. Cells for this could be: Models = "Assessment of sites important for biodiversity", Inputs = "Site populations of species or ecosystem extents meeting thresholds of significance", Outputs = "Sites contributing significantly to biodiversity persistence", Examples = "Important Bird & Biodiversity Areas (IBAs), Alliance for Zero Extinction (AZE) sites, and other Key Biodiversity Areas", Ecosystem services = "Regulating, Habitat, Provisioning, Cultural and Amenity", Examples = "Climate change mitigation, freshwater provision, cultural services and option values yielded from safeguard of AZE sites (Larsen et al. 2012 PLoS ONE), assessment of multiple ecosystem services at IBAs (Peh et al. 2013 Ecosystem Services)". The reference to be added to lines 2–8 would be "Key Biodiversity Areas (Eken et al. 2004 BioScience)".	Thomas Brooks (TB)	We think that this work should be covered in chapter 5, but that it is not related to the overall aim of the table, which only lists work on modelling and scenarios. One main message emerging from this table is that the state-of-art in biodiversity modelling appears to be underused in ecosystem service modelling and scenario work.
82.	6	7	19			I don't understand the cross-reference to Chapter 3.3.2.5, which is about climate change.	Thomas Brooks (TB)	Apologies for the oversight. The reference to different parts of chapter 3 here should refer to subchapters in

Nr	Chapter	From page	From line	Till page	Till line	Comment	Reviewer Initials	What was done with the comment
								chapter 4. We still have to update the subchapters once we get close to final versions of chapter 4 and 5.
83.	6	7	19	7	20	Add citation for the Lynx study; or maybe delete – is this necessary, given the citation of the work for all mammals.	Thomas Brooks (TB)	The lynx study is not mentioned anymore in the text, which we have rewritten. It is now only given in the table (Kramer-Schadt et al.)
	6	8	24			I wonder if this should be a separate subsection, parallel with the second row of Table 6.1?	Thomas Brooks (TB)	We think that it is better to cover IAMs separately. If we tried to cover everything in the table, it would probably become incomprehensible.
85.	6	11				Fig 6.3. Presumably scales of ecological organization could usefully be added to this, spanning from genes through species to ecosystems? More generally, it would be useful to align the components of this figure to the subsections under 6.4.1.	Thomas Brooks (TB)	We have included a new figure (Fig. 6.2) which have explicit representation o f the scale of ecological organization.
86.	6	12	10			Something wrong with this sentence.	Thomas Brooks (TB)	This is now revised.
87.	6	12	13			Delete "ecosystems and" – ecosystems are part of biodiversity	Thomas Brooks (TB)	Done.

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88.	6	12	21	12	32	Another good example is the downscaling of the Red List Index from global to grid cells, ecoregions, and countries – finer spatial, ecological, and institutional scales respectively (Rodrigues et al. 2014 PLoS ONE). Downscaling from global to national scales is also discussed more broadly by Han et al. (2014) PLoS ONE. Both would be useful additions here.	Thomas Brooks (TB)	Thanks for the comment but we have deeply revised the section on scaling and removed the section it was referring to.
89.	6	13	8			"usually" is a bit of an overstatement; "sometimes" would be better.	Thomas Brooks (TB)	Done.
90.	6	14	37			"strength-based"? – what does this mean?	Thomas Brooks (TB)	"strength-based" has been removed from the text
91.	6	15	14			Turner et al. (2012) BioScience provide another example of modification of benefits-transfer approaches to address some of the limitations of ecosystem service measurement and mapping.	Thomas Brooks (TB)	The example from Turner is now cited in the revised chapter.
92.	6	15	24	15	38	See Turner et al. (2012) BioScience again, here.	Thomas Brooks (TB)	See above.
93.	6	16	8			Table 6.3 is not just marine.	Thomas Brooks (TB)	In the revised draft, we have turned Table 6.3 into a Figure (Fig. 6.4), with the appropriate caption.
94.	6	19	4			No subsections on standardisation of methods or of metrics? (or, come to that, of classification schemes and taxonomies)? Maybe useful to add brief subsections on these, aligned with the rows in Table 6.1?	Thomas Brooks (TB)	Although we do not have an independent subsection, this topic is discussed in other relevant subsections. We are considering the possibility to add

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								this subsection but will have to balance the benefit of it with severe space constrains.
95.	6					This is an excellent chapter overall – many congratulations to the authors on such a well-structured, comprehensive, and useful piece of work.	Thomas Brooks (TB)	Thank you.