

## Comment form for 1<sup>st</sup> Review Phase of the Deliverable 3c) Fast-track methodological assessment on scenarios and models Chapter 5 ‘Ecosystem Services’

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### Reviewers:

Bartosz Bartkowski (BB)

Joel Houdet (JH)

Megan O’Rourke (MR)

Joseph Bigirimana (JB)

Daniel P. Faith (DPF), on behalf of bioGENESIS

Joachim H. Spangenberg (JHS)

Inge Liekens (IL)

Louise Gallagher (LG)

Wei Zhang (WZ)

Sebastien Lizin (SL)

Thomas Brooks (TB)

Eirik Romstad (ER)

Wisdom Akpalu (WA)

Patrick O’Farrell (POF)

Taylor H. Ricketts (THR)

Nr	Chapter/ Section	From page	From line	Till page	Till line	Comment	Reviewer Initials	Response
1.	5.2.1	3	3	3	20	‘BES’ is used as de facto synonymous with ‘ecosystem services’—either it should be shown what the connection between biodiversity and ecosystem services is or the ‘B’ should be dropped as redundant; also, attention should be paid to the difference between ‘biodiversity’ as a certain property of ecosystems, and those ecosystems themselves	Bartosz Bartkowski (BB)	We removed term BES
2.	5.2.1	3	8	3	20	This passage sounds a little bit as if the authors would like to “force” a relationship between ecosystems and well-being, as they first state that “large part of the consumed material goods and services by humans rely ultimately on BES provisioning”, focusing on material well-being, just to immediately after that admit that ecosystems are being degraded while metrics of material well-being (GDP) are growing—is the starting point the ad hoc assumption that ecosystems (‘BES’) are good/important, or is it a hypothesis that is to be tested?	Bartosz Bartkowski (BB)	clarified - added discussion of environmentalist’s paradox on this point
3.	5.2.2	4	29	4	30	Are you suggesting that ES are ‘anthropogenic assets’? Or do you mean that they only can provide benefits to humans if combined with such (in line with Boyd and Banzhaf 2007)?	Bartosz Bartkowski (BB)	Note that Boyd and Banzhaf 2007 state that “Once

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								ecosystem services are combined with other inputs, such as labor and capital, they cease to be identifiably “ecological?”. We understand from the IPBES conceptual framework that even though some services resulting from nature need the support/use of anthropogenic assets to reach out final users (e.g. the use of vessels for fishing), they still are an ecosystem services. In this end, we can see these two views as an issue of the boundaries where in our case we set the boundaries in line with e IPBES conceptual framework.
4.	5.2.2	4	22	5	35	The title of the section promises much more than it actually delivers. Only examples of two-way interactions are sketched, but a bigger picture is missing (from BES via anthropogenic assets and institutions to HBW). Should be formulated more thoroughly and clearly. What’s the aim of this section?	Bartosz Bartkowski (BB)	Both title and section have been revised
5.	5.2.3.1	6	5	7	15	The distinction between drivers and their underlying sources should be made more clear. For instance, population growth (listed as example of a direct driver in section’s 5.2.3 introduction) is NOT a direct driver, as it only triggers direct	Bartosz Bartkowski (BB)	We agreed. Done

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						drivers such as climate change or land conversion.		
6.	5.2.3					The distinction between how drivers affect BES and how they affect HBW should be made clearer. More often than not the discussion is only about BES, HBW seeming to have been inserted afterwards to fit the title of the section.	Bartosz Bartkowski (BB)	Noted and revised
7.	5.2.3.3	7	28	7	31	Why are land-use changes suddenly indirect drivers?!	Bartosz Bartkowski (BB)	Revised
8.	5.2.3.3	7	37	8	11	If it is on purpose that only institutions are picked out as an indirect driver, this choice should be explained. Furthermore, the section appears overly Barbier-dominated. What about Elinor Ostrom?	Bartosz Bartkowski (BB)	Revised
9.	5.4.2	22	6	22	8	[Table 5.1] Why are informal governance systems supposed to be “simple”?	Bartosz Bartkowski (BB)	They are often not table is revised
10.	5.4.3	22	21	23	2	ESS have been conceptualised in an inherently human well-being-centred manner, so why is there (allegedly) a “historical lack of collaboration between people studying human wellbeing and those studying ecosystem services”?	Bartosz Bartkowski (BB)	Unpacked this is not point of our chapter. Discipline studying human wellbeing are mostly the health and psychology sciences; EES theory evolved in the ecology and ecological economics disciplines. Only rarely do these disciplines collaborate. Perhaps collaborations are becoming more common now.
11.	5.4.4	23	11	24	2	Normative/decision uncertainty is mentioned only in the beginning, the complete following discussion focuses on information/knowledge uncertainty. This is a serious omission.	Bartosz Bartkowski (BB)	We have tried to address - but how models are used is focus on chpt 2 - uncertainty is focus of chpt 8
12.	5.3	10	22	10	34	These issues are critical should be discussed from the perspective of different stakeholder groups (e.g. government, business, local communities).	Joel Houdet (JH)	These issues should be discussed in chapter 2 on decision contexts - we need to ensure

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								chapters align
13.	5.4.2.3	20	36	21	17	Many general green accountign approaches are missing, especially the ones used by business. Mention should eb made of the Natural Capital Protocol which intends to provide some guidance on how to value impacts and dependencies of businesses on biodiversity and ecosystem services	Joel Houdet (JH)	we do not have space to include all methods - and focus is ecosystem services not green accounting; green accounting section has been revised
14.	5.4.3	22	6	22	8	What about different user groups??? They have differemt value perspectives (e.g. private vs. Social costs and benefits).	Joel Houdet (JH)	We have tried to address - but how models are used is focus on chpt 2 - uncertainty is focus of chpt 8 - however we have included more focus on multiple beneficiaries
15.	Overall					This seemed like an extremely rough draft that is difficult to comment on because many of the sections that seem to be the most important for the chapter have not been written. Much of what is written, especially section 5.2 seems like it could be cut or extremely reduced during final edits.	Megan O'Rourke (MR)	It was a rough draft - hopefully it has been improved - 5.2 has been re-written and greatly shorten
16.	Overall					This is obviously a rough draft but the voices of different authors interupts the flow. Also, the length and depth of different sections is imbalanced. For example, there is much more information about inVEST compared to the other models.	Megan O'Rourke (MR)	We have tried to improve consistency Comment already made by other reviewers. Balance is on purpose
17.	Overall					Reading this chapter out of context from the whole, it is not clear how chapter four and five will be differentiated. Sections 5.4.1-5.4.3	Megan O'Rourke (MR)	Should be made clear with a paragraph at the beginning hopefully clarified in new version - 4 more biodiversity 5 - more social-ecological
18.	Overall					It seemed like the paper didn't start to provide clearly useful information until section 5.3. Section 5.2 seemed a really long way to describe the information	Megan O'Rourke	section revised and shortened

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						embedded within figure 5.1. This section could definitely be streamlined	(MR)	
19.	Overall					The authors introduce the term BES. I think this is misleading as a concept and difficult to understand in relation to figure 5.1. Biodiversity and ecosystem services are not always directly correlated, but putting them into one term implies that they are. Furthermore, figure 5.1 shows biodiversity and ecosystems in one box and ecosystem good and services in another box, not as a single BES box.	Megan O'Rourke (MR)	term BES is removed.
20.	Overall					It is mentioned many times that things are difficult to model or have not yet been modeled. There is a place for pointing that out, maybe in a table or some concise form. However, the extension narration in section 5.2 about what is not know or not modeled is not particularly informative.	Megan O'Rourke (MR)	we have added several tables
21.	Figure 5.1					I mentioned in my review of chapter one that I did not find this figure particularly useful as a conceptual framework. There is too much information and some logical inconsistencies. For example, why are direct drivers labeled but indirect drivers are not? Why do anthropogenic assets get their own box separate from anthropogenic drivers? Why are there no examples of natural drivers? I could also argue that more connections exist than are labeled so why were these particular arrows represented in the figure?	Megan O'Rourke (MR)	This is the IPBES framework. So it remains as is We have tried to expand on some of the issues for this chapters; and make sure figure is explained in chpt 1.
22.	Sections 5.2.1-5.2.4					Given that I think Figure 5.1 should be carefully reconsidered with a focus on its usefulness for communicating this work to a non-specialist audience, sections 5.2.1-5.2.4 would need to change since they are essentially describing section 5.1. These sections seemed like ones I just want to skip/skim to get to some solid information.	Megan O'Rourke (MR)	This is taken care of when revising the chapter
23.	Overall					There are many seemingly random keywords highlighted throughout the paper. They do not seem useful.	Megan O'Rourke (MR)	Don't know what happened, but should not be case in this version
24.	Section 5.4.2					A table comparing the pros and cons of different modeling approaches would be useful	Megan O'Rourke (MR)	Such a table is in this version
25.	Table 5.1					In the current form, this is not very informative. It appears to be a list of antonyms.	Megan O'Rourke (MR)	was placeholder; replaced
26.	5					This review transition manuscript already addresses in eminently pedagogic way the aspects related to modelling consequences of change in biodiversity and ecosystems for nature's benefits to people. I encourage the authors to include into the next version the improvements already planned for some of those aspects.	Joseph Bigirimana (JB)	comment vague - not clear what reviewer feels is missing
27.	5	5-8				About " <b>Identifying and quantifying drivers of BES and HWB changes</b> ": Human factors being currently the dominant drivers of change in biodiversity and ecosystems, I think it is appropriate to discuss the difficulty now, to clearly distinguish the natural drivers from anthropogenic drivers. Thereafter, it would be	Joseph Bigirimana (JB)	Drivers are Chapter 3 - we use IPBES conceptual framework

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						interesting to explain how you overcome this conflict situation by taking position to differentiate the two groups of drivers.		
28.	5					Some minor comments include: - Redundancy between the text from line 31 to line 37 on page 21 and text from line 9 to line 14 on page 22. - Some typing errors through the central text that you will undoubtedly correct by rereading it. - Problem of frequent non-uniformity in citation and references models that could be easily solved by using the Endnote program.	Joseph Bigirimana (JB)	we are working for consistency
29.						<p>The review of these first order drafts is intended to determine whether they are “heading in the right overall direction”. My assessment of Chapter 5 is that it is not completely heading in the right overall direction. I outline my concerns below.</p> <p>Deliv 3c, Chapter 1 “Overview and vision” sets the scene for Chapter 5. “Chapter 5 focuses on “modelling consequences of change in biodiversity and ecosystems for nature’s benefits to people”. It explores challenges associated with translating modelled biophysical changes in biodiversity and ecosystem properties and processes into expected consequences for benefits to people, by incorporating consideration of relevant values that people place on, or derive from, nature. It emphasises the importance of recognising that different decision-making processes may require a focus on different types of material and non-material values, including various ecosystem goods and services. Approaches to modelling consequences of changes in biodiversity and ecosystems for different types of benefits to people are reviewed and evaluated.” So, the chapter logically follows chapter 4 on “the impacts of drivers on biodiversity and ecosystems”</p> <p>It appears that Chapter 5 justifiably will talk about models of the consequences of change in biodiversity and ecosystems for benefits of different types, but must also go beyond that to incorporate society’s values regarding those benefits, in order to link to human well-being,</p> <p>Critically, Chap 1 also says that Chapter 5 explores “the consequences of changes in biodiversity and ecosystems for the benefits that people derive from nature, and that therefore contribute to good quality of life (human well-being) – including, but not limited to, ecosystem goods and services.” This is a key description; the chapter currently focuses only on ecosystem goods and services. Yet biodiversity loss has consequences for other benefits. The critical gap in the draft is that it does not appear to be on track to</p>	Daniel P. Faith (DPF)	<p>Key goal of chapter is to review models of ES</p> <p>we agree that values are critical but they are not included in current models and we have more clearly identify these gaps</p> <p>option &amp; quasi-option value of biodiversity combines with other aspects in this section - chapter 4 should be focused on value by itself.</p> <p>we will make sure option value is mentioned - but don’t believe it is assessed in current models</p> <p>We are working to make this important gap clearer</p>

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						<p>consider the key theme regarding impact of biodiversity loss on benefits and human well-being. This key theme is the loss of option values of biodiversity.</p> <p>Any chapter titled “Modelling consequences of change in biodiversity ... for nature’s benefits to people” needs to address existing modelling approaches describing change in distribution of option values, and trade-offs involving option values. Existing modelling approaches of interest also describe how society’s valuation of maintaining options synergises/trades-off with other values/benefits,</p> <p>I note that Observer organisation bioGENESIS (a Project within Future Earth) previously provided comments on option values for the Conceptual Framework, and proposed an assessment addressing the multiple values of biodiversity. IPBES/2/INF/9 concluded that the bioGENESIS suggestion has “High priority for inclusion in regional and global assessments”.</p> <p>I note the bioGENESIS submission for IPBES3:  “ “Biodiversity” refers to living variation. A core benefit/value of such variation is the option value of biodiversity. In accord with this, the IPBES Conceptual Framework (IPBES/2/INF/2/Add.1) lists anthropocentric values including “the option values of biodiversity as a reservoir of yet-to-be discovered uses from known and still unknown species and biological processes, and as a constant source, through evolutionary processes, of novel biological solutions to the challenges of a changing environment [11].” (quoted from the published version of the Conceptual Framework; Diaz et al 2014, Current Opinion in Environmental Sustainability). The Glossary in Diaz et al. also refers to “The ‘option values of biodiversity’, that is, the value of maintaining living variation in order to provide possible future uses and benefits”.”</p> <p>In accord with the IPBES conceptual framework, retaining biodiversity means retaining “option value” - the benefit in maintaining something in the absence of knowledge about its future benefits. Thus, while chapter 5 properly sets out to discuss multiple benefits in the context of the Conceptual Framework, its current focus only on ecosystem services means that it currently is not on track to do this. In the current draft, biodiversity largely is treated in its conventional limited role, within an ecosystem, as the supposed basis for providing ecosystem services. Limitations arise from a lack of consideration of biodiversity as living variation, with its typically global option values. For example, the chapter says that the Balvanera et al study “demonstrated through a meta-analysis that increased biodiversity has a positive effect on supply of most ecosystem services” But one needs to sort out the multiple uses of “biodiversity” in such studies (“evenness” etc), and reconcile these with the IPBES definition.</p>		

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						<p>(elsewhere in the chapter, this same kind of problem with definitions appears: “the biodiversity metrics incorporated into the BES models may require estimates of species richness and evenness (index of high diversity) or simply presence of desired functional groups (e.g., extensive plantations of monoculture species or targeted species).” This use of the term does not link well to the definition of biodiversity).</p> <p>The chapter also refers to the excellent Cardinale et al study, which also has been used to argue that biodiversity provides ecosystem services. But that study in examining ecosystem services such as crops and wood production, ignored the loss of biodiversity (and global option values) from transforming the land and only looked at the issue of having more versus less diversity in the transformed system.</p> <p>Thus, chapter 5 needs to address the interplay among these local and global benefits.</p> <p>I recall that the Millennium Ecosystem Assessment , in referring to biodiversity loss, argued that ‘global loss is more a concern about long-term option values, and hence defines a critical knowledge gap that goes beyond current perceived services.’</p> <p>The Millennium Ecosystem Assessment noted that pursuit of ecosystem services (timber production etc) was a major cause of biodiversity loss.</p> <p>Thus, while the Balvanera et al study is cited as evidence in this draft chapter that “increased biodiversity has a positive effect on supply of most ecosystem services”, one needs to properly consider that <i>decreased</i> biodiversity has a positive effect on supply of many ecosystem services.</p> <p>All that is of course about synergies and trade-offs among different benefits (and society’s values of benefits). It will be useful to see the chapter cover this more. It says “understanding, quantifying and mapping the flows of services to beneficiaries, an area of research only recently emerging.” But there is an older literature on this, including both ecosystem services and biodiversity option values, and this should be explored. For example, in the Catalogue of assessments – the early 90s multi-criteria analysis framework of Cocks et al has been used to explore multiple local to regional/global benefits and society’s preferences regarding these.</p>		
30.	5	1	25	1	25	True if not different models are based on the same assumptions – otherwise pseudo-certainty is the result	Joachim H. Spangenberg (JHS)	This has been taken care off in the revised draft.
31.			31		31	Focussing so strongly on modelling while definitions are disputed and functional mechanisms are unclear carries the risk of putting the cart before the horse	Joachim H. Spangenberg (JHS)	This has been taken care off in the revised draft.

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32.	5.2.1	3	1	8	11	Treating biodiversity and ecosystem services as BES is difficult, as this summary results not only in a number of questionable formulations throughout the text (Generating or providing BES – possible for ES, but for B?), it also treats them as both nature's gifts, while B is an anthropogenically defined characteristic of natural systems, while ES in IPBES parlance are a co-production of Nature, Anthropogenic assets and Institutions and governance (figure 5.1) and thus no characteristics of ecosystems, but of human-nature interactions	Joachim H. Spangenberg (JHS)	The term BES is no longer used
33.		3	9		10	B is a stock, ES is a flow, income is a flow, food production is a process, raw materials are a stock – this does not fit together as it stands	Joachim H. Spangenberg (JHS)	revised
34.		3	10		10	Reduction in HWB – not necessarily: if it depended on functions, no effect if functional groups still intact. If it depended on biomass provision as in food production, increasing one ES at the expense of the others, and thereby possibly reducing biodiversity has been the way to enhance HWB	Joachim H. Spangenberg (JHS)	specific statement is no longer present; and discussion of how simple ag ecosystems are big contributor to HWB
35.		3	18	3	41	Here and later, HWB is described in a most confusing way. While there is indeed much confusion in the literature, scientists from different disciplines using proxies they know best, this should not be reiterated here without any structuring. At least wealth as a stock (accumulated, key criterion: ownership), welfare and income as flows (permanent, key criterion: access) and well-being as a state (objective or subjective, key criteria: surpassing objective thresholds and subjective feeling of life satisfaction) can be distinguished by their very character and are no proxies for each other but describe aspects of HWB which may differ in their relative importance over space and time, cultures and social strata. Max-Neef et al and the distinction between human needs as anthropological factors and the corresponding satisfiers as culturally determined factors may help understanding the link between objective and subjective factors. Both are complementary and relevant to decision making and public acceptance.	Joachim H. Spangenberg (JHS)	we have tried to clarify - models treat HWB inconsistently
36.		4	6	4	7	(is repeated later in more detail). Green accounting is monetising some of the environmental flows, and taking others as satellite accounts, complementing the System of National Accounts SNA as defined by UN Stat, turning it into the System of economic and environmental accounting SEEA, also defined by UN Stat (last updated version 2013). A further amendment integrating ecosystems as assets into the system is still being tested; it measures the value of ecosystems by their restoration cost as all other cost indices are not in line with the basic SNA approach, and thus are not suitable for green accounting (in particular WTP/WTA analyses, but all other revealed or stated preference valuations as well, for different reasons). Thus green accounting, like the SNA, is exclusively based on the valuation of market processes (real or hypothetical) and has nothing to do with HWB. TEEB does not claim to measure UWB with economic means, on the contrary: confusing both is rejected in several TEEB reports.	Joachim H. Spangenberg (JHS)	people use green accounting methods to link nature to HWB and therefore it is included in this chapter

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37.			8		8	When talking about life satisfaction, one of the frontrunners has been Ruut Veenhoven who now runs the World Happiness Database	Joachim H. Spangenberg (JHS)	Noted, but we aren't reviewing HWB
38.			11		11	Wealth per unit area says nothing about HWB, except maybe for the well-being of the owner of that particular piece of land – social factors are decisive	Joachim H. Spangenberg (JHS)	Nothing is a bit strong, but Noted and revised
39.			12		12	See no. 3 - BES can be produced – can B be produced?	Joachim H. Spangenberg (JHS)	term BES removed
40.	5.2.2	4	25	5	35	Beginning in line 25, the text implies that there are BES, and there are assets, and both together provide the basis of HWB, as if BES were independent of assets. However, according to the IPBES figure, nature (including B), assets and institutions are the three production factors which together generate ES. L 28/29 states that assets provide services – a plough does not do so unless there is a field to use it on (access and use rights, i.e. institutions). ES are co-produced by humans (assets), societies (institutions) and nature (see chapter 1-3). L. 32 names enjoyment as an ES which is usually considered a typical benefit, not a service. I suggest defining and distinguishing ecosystem processes and functions (the biological domain, see earlier chapters) which through a social process of value attribution are turned into service potentials (also called resources or reserves). Through the next social process, mediated by institutions setting limitations and providing incentives the ecosystem potentials are mobilised (including the investment of energy, resources, work, time and skills) to generate ecosystem services. To generate ecosystem benefits, the services have to be appropriated (again mediated by institutions, albeit different ones) before people can sell or consume the benefits. Without taking these steps of the ES cascade into account (Potschin & Haines-Young, several publications since 2010, and the social processes linked to each transformative step (Spangenberg et al. 2014, von Haaren et al. 2014) the link from B via ES generation to HWB cannot be fully understood.	Joachim H. Spangenberg (JHS)	Should be done in section 5.2.1
41.			29		29	Who decides what is valuable for to people's lives: the people themselves? Governments? External experts? Is "valuable" subjective, or externally defined and imposed on people and their livelihoods? If not valued by people, no economic value exists (not even a value of zero) - one reason why Harrington et al define ES as benefits recognised by humans as generated by nature. Overall, a clearer structure distinguishing stocks/funds and flows, and assets and processes, would be helpful to structure the chapter.	Joachim H. Spangenberg (JHS)	Done
42.		5	8		8	See no. 12: social capital is a stock, but leaves out social processes, work and time (although the latter are mentioned later on)	Joachim H. Spangenberg (JHS)	We agree. Revised
43.			17		26	Institutions mediate the social processes. They are decisive for limiting the disservices often co-produced with certain services, and to care for an adequate	Joachim H. Spangenberg	We agree. Revised

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						distribution of the benefits and disbenefits emerging (whatever 'adequate' may mean in the local circumstances).	rg (JHS)	
44.			29		35	Technology is not only machines, but can also be social – skilful gathering is maybe the oldest machine-free social technology, requiring collaboration, knowledge (what and how much), etc. Gardening and cultivating are other examples.	Joachim H. Spangenberg (JHS)	Taken into account in revisions
45.			30			Potential BES? Potential ES as described above is ok, but potential B?	Joachim H. Spangenberg (JHS)	We do not use BES now
46.			34			A drop in prices indicated oversupply, not overexploitation	Joachim H. Spangenberg (JHS)	We agree.
47.	5.2.3.1	6	6	6	6	BES productivity: definition?	Joachim H. Spangenberg (JHS)	BES removed. Dropped in revised version.
48.		6	6	6	27	Agriculture is described as the culprit. It should be mentioned that traditional agriculture, from shifting cultivation to the mechanization phase, has often enhanced biodiversity by creating more richly structured landscapes (leaving aside the draining of wetlands for the moment). It is modern, post-Green Revolution, monoculture based and highly chemical intensive agriculture which leads to the effects described.	Joachim H. Spangenberg (JHS)	Noted.
49.			32		38	This is the “Tragedy of the Commons” and the Indira Ghandi argument that “Poverty is the worst pollution” combined – both have been falsified. There are few public goods outside the high sea and the atmosphere; ecosystems are almost always regulated, by formal or informal institutions and processes, as Elinor Ostrom and collaborators have shown in a wide range of studies. Martinez-Alier has analysed the “Environmentalism of the Poor” as a necessary self-defence of their livelihoods, and Sukhdev when calculating bathe “GDP of the Poor” showed their higher dependence, and the resulting higher awareness of the value of intact ecosystems. The latter point – low income is not correlated to low environmental awareness – was recently confirmed in several studies; it had been overlooked in WTP analyses which were biased by income level.	Joachim H. Spangenberg (JHS)	Some of these have been dropped in the revised document.
50.		7	10 ff			I wonder why invasive species, one of the most important drivers of biodiversity loss, and the vectors providing their immigration opportunities (Global trade, insufficient phytosanitarian controls to not disturb trade, and climate change effects) are not mentioned at all in this chapter, although scenarios and models are available (see e.g. Chytrý et al. 2011)	Joachim H. Spangenberg (JHS)	Mentioned in section 5.2 these are addressed in chpt 4 which focuses on modelling biodiversity
51.							Joachim H. Spangenberg (JHS)	

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52.	5.2.2.3	7	30			Prices and markets – if ES not defined as “valued by beneficiaries” neither markets nor prices may exist	Joachim H. Spangenberg (JHS)	Noted
53.			37			Institutions are defined differently in economics (traditional and new), jurisprudence, sociology, history and political science. In any case they can be formal and informal, explicit or implicit. In political science institutions have been classified as either organisations, mechanisms or orientations (see e.g. Spangenberg et al. 2002). Given that wide range, a discussion and a clear definition of the terminology used in this report seems desirable.	Joachim H. Spangenberg (JHS)	Noted and done; see chpt 1 & conceptual framework
54.		8	1	8	11	To understand the cases, it would be helpful not to remain completely descriptive but add some analytical elements: In some cases political good will has failed due to a lack of knowledge (in other cases, for political-ideological reasons). In the other cases, private interest either ignored the impacts on the common good and was not reined in by institutions, in other cases ideological reasons (growth) or bribes lead to a corporate take-over of public institutions	Joachim H. Spangenberg (JHS)	See analytical elements in sections 5.3 and 5.4. More than this is beyond the scope of the chapter.
56.	5.2.4	8	23			And later in the text: available data is not the only challenge – we are dealing with uncertainties which cannot be reduced to data availability, but combine it with lack of understanding and knowledge, and elements which are characterised by ignorance, and unknowable system traits.	Joachim H. Spangenberg (JHS)	we have expanded our discussion of model uncertainty - this is also feature of discussion of alternative modelling approaches
57.	5.3.2	12	10	12	17	Biophysical models cannot represent the process of ES generation, as the ES generation occurs as a co-production of nature, institutions and assets (IPBES graph) and social processes, as argued earlier. For ES assessments, benefits and disbenefits and their social distribution have to be taken into account.	Joachim H. Spangenberg (JHS)	Noted. Different models have different purposes.
58.		12	19	12	24	Production functions are only usable for marginal changes not affecting structures and based on linear relations; they fail for long term developments.	Joachim H. Spangenberg (JHS)	Noted. We have a bigger model comparison section
59.		13	2	13	2	“on ecosystem service supply” of a few selected ES	Joachim H. Spangenberg (JHS)	Revised - BR
60.	5.4.2	13	10	13	16	Missing: combined models, coupling econometric, land use and biodiversity models, see e.g. the GEB 21 (2012), special issue on scenarios, and the publications from the ALARM project	Joachim H. Spangenberg (JHS)	IAM are addressed - now in chapter - IMAGE mentioned by name
61.		13	20	13	20	“human populations and demographics”, tastes, preferences, incomes	Joachim H. Spangenberg (JHS)	revised
62.			21		21	Demand for natural capital – probably does not exist, but the demand for services does.	Joachim H. Spangenberg	Text revised to clarify, people value

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							rg (JHS)	services but people also value natural capital - i.e. people protect, buy places.
63.	5.4.1.1	14	5	15	13	A state is no proxy for a flow, deriving flow potentials requires assuming unchanged institutional settings and assets. For more matrix and knowledge models see GEB (2012). Not changes in supply, but in supply potentials can be assessed. Regarding proxy model transfer, in particular the Costanza approach, a whole range of literature exists criticising it for environmental economic and ethical-philosophical weaknesses (see the special issue of Ecological Economics 1998) – it should not be presented here as if common sense and accepted by the scientific community: it isn't.	Joachim H. Spangenberg (JHS)	This point is not correct. A state can and is widely used as a proxy for a flow in many models across all fields. This is often reasonable because flows and states are co-created and highly inter-related. The adequacy of approximation depends on context and use. Hopefully new version addresses some of these issues, but this chapter is review of models of ecosystem services not at systemic review of ecological economics.
64.	5.4.3.2	16	3	16	3	"to implement", focussing on one or a selected few ES, neglecting trade-offs and other interactions.	Joachim H. Spangenberg (JHS)	Revised to include this. - BR
65.	5.4.1.3	16	13	16	21	Probabilistic models – Bayesian, fuzzy or whatever else – do NOT allow for the treatment of uncertainty, as they emulate random variations, i.e., a deterministic model with not a single figure result but a probability distribution as outcome. Uncertainty includes situations of unknown probabilities, unknown distributions, and even unknown effects (ignorance) and cannot be overcome by probabilistic approaches. See for instance the policy guidance for decisions under uncertainty developed by van der Sluijs et al. for the Copernicus Institute of Utrecht University, the homepage of the Uncertainty Research Community etc.	Joachim H. Spangenberg (JHS)	We have specified that these models address stochastic uncertainty - BR
66.	5.4.2.1	18	2	18	2	"value of" a pre-defined range of "ecosystem services..."	Joachim H. Spangenberg (JHS)	Revision made - BR

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67.			6		6	“or economic terms” based on assumptions regarding future price and cost developments...	Joachim H. Spangenberg (JHS)	Revision made - BR
68.	5.4.2.2	20	18	20	18	Boumans has developed an integrated approach combining agent based modelling with MIMES, maybe the most comprehensive approach so far (pers.comm).	Joachim H. Spangenberg (JHS)	Its now mentioned, but MIMES is not well documented
69.	5.4.2.3	20	36	21	18	See the earlier comment on SNA, SEEA and ecosystem valuation – the text needs to be updated to take the UN Stat SEEA revision process into account	Joachim H. Spangenberg (JHS)	Added a more specific mention of the SEEA-EEA and citation to the key document
70.	5.4.3	21	31	22	9	I am missing a description of the storyline and simulation SAS approach developed by Alcamo; it is the most helpful one understand that storyline capture qualitative factors models cannot integrate, and that model runs serve to illustrate certain aspects of scenario, not more and not less.	Joachim H. Spangenberg (JHS)	Added to discussion of participatory scenarios.
71.	5.4.3 (no. appears twice)	22	10	23	9	Co-production, disservices and distribution missing again. Mention: role of institutions and assets often underestimated, and social processes overlooked.	Joachim H. Spangenberg (JHS)	These are now included in this section - BR
72.	5.4.4	23	18	23	29	See comment on uncertainty: it is definitely not only in the data. Reducing systemic uncertainty to statistical uncertainty, and then further reducing the statistical one, is impossible and would bring us close to a predictable world. It is also not in line with earlier chapters in this report. Distinguish the “not (yet) known” and the “unknowable”	Joachim H. Spangenberg (JHS)	Uncertainty section was revised as suggested - BR
73.	5.2.1	3	15	3	18	I would not formulate that so strongly. It depends on the indicator if human wellbeing is indeed increasing. On global level maybe, but if you look to more sustainability indices than is HWB in a number of regions (especially developed world) declining due to e.g. psychological issues, happiness, inequality etc. You mention it in the text following this sentence.	Inge Liekens (IL)	We’ve added more discussions on global dynamics of ES & HWB
74.	5.2.3.3.	7	31	7	32	Strange sentence	Inge Liekens (IL)	Dropped
75.	5.3	10	33			Mistake in sentence	Inge Liekens (IL)	Fixed
76.	5.4					I would put the cases more in boxes. Sometimes the theory and message are very hard to grasp because cases interrupting the flow of the explanation.	Inge Liekens (IL)	We have rewritten to the chapter to make it clearer; hopefully readability is improved
77.	5.4	19				Ecopath: does it fits here? I do not know the model but does it encounter as much ecosystem services as possible or only fishery? If it is the latter I do not think it is a good example as assessing the total bundle of ES and trade-offs is essential for	Inge Liekens (IL)	Have section on ecopath/ecosim - fisheries focused but



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85.	5.4					Section 5.4: It seems like most of the models reviewed focus on modeling impacts on ES flows. The link with human well-being is weak—either too aggregated (e.g., green accounting) or not based on empirical socio-economic analysis. Benefit transfer is used in some models as a substitute for field data based economic valuation, which is practical but not always ideal because of the disconnect with local context. It is rarely the case that survey data-based economic valuation or social analysis is conducted in case studies where ES models are implemented. Therefore, there is a need to strengthen the social and economic assessment of the human well-being implications of ES change which would improve the validity of bio-economic modeling.	Wei Zhang (WZ)	Agree, we discuss this more in depth in 5.4.3 - BR
86.	5.4.5					In addition to the economic data outlined here, I would suggest adding data that support broader socio-economic assessment. In addition to economic value metrics, non-monetary indicators that capture other dimensions of wellbeing (e.g., spiritual well-being, equity) should be considered.	Wei Zhang (WZ)	Agree, this has been added -- BR
87.		1	11			, but risks hiding .. (add s)	Sebastien Lizin (SL)	Fixed - BR
88.			13			approach, tool, or process is appropriate (make singular)	Sebastien Lizin (SL)	Editorials- general revision of chapter
89.			22			produces (add s)	Sebastien Lizin (SL)	Editorials
90.		3	3			contribute (delete s)	Sebastien Lizin (SL)	Editorials
91.			8			parts (add s)	Sebastien Lizin (SL)	Editorials
92.			22	24		sentence unclear	Sebastien Lizin (SL)	Editorials
93.			24			metrics HWB unclear	Sebastien Lizin (SL)	Editorials
94.			27			I suggest numbering the five dimensions	Sebastien Lizin (SL)	Editorials
95.		4	10			people's access (add s)	Sebastien Lizin (SL)	Editorials
96.			25			the basis (add the)	Sebastien Lizin (SL)	Editorials
97.		5	22			it may (delete)	Sebastien Lizin (SL)	Editorials
98.			22			recreational ecosystem services are (replace is)	Sebastien Lizin (SL)	Editorials
99.		6	8			result in (replace results to)	Sebastien Lizin (SL)	Editorials
100			9			mono-crop	Sebastien Lizin (SL)	Editorials

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101		5-8				replace 5.2.3.1-5.2.3.3 by a simple table	Sebastien Lizin (SL)	This has been revised.
102		10	22			decision context (delete s)	Sebastien Lizin (SL)	Editorials
103			33			replace & by what	Sebastien Lizin (SL)	Editorials
104		16	27			sentence unclear: models of ecosystem services ...	Sebastien Lizin (SL)	Sentence was revised - BR
105		17-21				reader would benefit from tables instead of text	Sebastien Lizin (SL)	We now include a table - BR
106	5	3	17			“measure of HWB such as material wealth is actually increasing” – this claim is highly debateable; at a minimum it should be cited, and caveat-ed with the fact that such HWB increases are a) highly heterogeneous across humanity, with the separation between rich and poor increasing, b) arguably unsustainable over anything other than very short timescales.	Thomas Brooks (TB)	We cited references to support this correct statement and discuss some of complexity.
107	5	4	25			From here on, this Chapter 5 uses text in bold and bold italics at numerous places in the text. This looks useful, but it is not clear what bold and bold italics actually indicates. Also the notation should be used consistently throughout the whole assessment, if bold and bold italics is going to be used in the text.	Thomas Brooks (TB)	Done
108	5	6	5	7	15	A good discussion in this Section 5.2.3.1, but duplicates Chapter 4. Consider shifting much of the material from here over to Chapter 4, just leaving a brief summary cross-referencing back to Chapter 4. Also, NB that the text here misses some key direct drivers like invasive species, (un)sustainable harvest, and pollution.	Thomas Brooks (TB)	Section has been shortened and revised - are working to ensure consistency with chapter 4
109	5	6	17	7	25	Again, Section 5.2.3.2 is a useful paragraph, but again it seems that this material would belong better in Chapter 4. Come to think of it, I didn't see any discussion of natural drivers in Chapter 4 – all the more reason to move this back there.	Thomas Brooks (TB)	Revised
110	5	6	27	8	11	This Section 5.2.3.3 is good – but again belongs earlier in the assessment, this time in Chapter 3.	Thomas Brooks (TB)	The section has been revised to avoid overlaps with chapter 3
111	5	8	22	8	35	Another approach, which circumvents this challenge, is to predict (e.g., Larsen et al. 2012 PLoS ONE) or measure (e.g., Peh et al. 2013 Ecosystem Services) ecosystem service provision from particular sites. Documentation of sites as being of particular importance for biodiversity (e.g., Eken et al. 2004 BioScience, Ricketts et al. 2005 PNAS, Butchart et al. 2012 PLoS ONE), in comparison to counterfactual sites elsewhere, allows inference regarding the connections between biodiversity and ecosystem services.	Thomas Brooks (TB)	Noted
112	5	10	11			Change “Ecosystem” to “Biodiversity” in title. Biodiversity encompasses genetic, species, and ecosystem diversity, and the remit of IPBES is to cover the full scope of biodiversity (Chapter 2 of this assessment; IPBES conceptual framework; also	Thomas Brooks (TB)	We can't change the title

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						consistency with CBD definition of biodiversity).		
113	5	10	10	13	6	This Section 5.3 is good, but again rather duplicative of earlier material, in particular Section 2.1. I suspect that quite a bit of the material here could usefully be shifted to Section 2.1, just leaving a summary of decision contexts directly relevant to ecosystem services and human well-being here.	Thomas Brooks (TB)	We have revised to reduce this duplication
114	5	13	18	13	21	This is a key distinction. Turner et al. 2012 BioScience used “potential ecosystem services” to describe the former (“supply side”) and “realized ecosystem services” (“demand side”) to describe the latter, adding a third class of “essential ecosystem services” to incorporate measures of reliance, poverty, and equity – the delivery of the same quantity of a given ecosystem service to different people can have completely different implications for lives and livelihoods. It would be worth adding this third approach here.	Thomas Brooks (TB)	Noted, but this chapter focusses on models not conceptual frameworks. We aim to better clarify what is missing from current models
115	5	13	21			“Chapter ???” – which Chapter? This is really important, and I’m disappointed not to see it covered here, but will be happy as long as it is covered elsewhere... On reviewing all eight chapters of the assessment, I don’t find this anywhere. It is a serious gap, and should be discussed.	Thomas Brooks (TB)	Placeholder clarified
116	5	14	13			Important to reflect the approach of predicting (Larsen et al. 2012 PLoS ONE) or measuring (Peh et al. 2013 Ecosystem Services) of important sites for biodiversity (Eken et al. 2004 BioScience, Ricketts et al. 2005 PNAS, Butchart et al. 2012 PLoS ONE) as “proxies” for biodiversity more generally here.	Thomas Brooks (TB)	Biodiversity modelling is addressed in chapter 4
117	5	15	12	15	13	This critique of Costanza et al. 1997 Nature is rather facile; the original paper is very clear on the caveats and limitations of the approach, and a number of subsequent refinements (e.g., Turner et al. 2012 BioScience) address some of them.	Thomas Brooks (TB)	Costanza paper has strengths and weaknesses - really side point to this chapter - we have revised discussion in this section
118	5	16	26	16	30	This three-fold classification, used to structure Section 5.4.2, is rather weak; there are many overlaps between the three supposed categories. The WBCSD 2013 Eco4Biz review gives a rather more balanced review of ecosystem service tools, and might provide some useful material to strengthen this section.	Thomas Brooks (TB)	This was a weak placeholder and has been completely revised
119	5	16	32	20	17	Section 5.4.2.1 is very unbalanced at the moment, with 67 lines devoted to one tool, 12 to a second, and 43 to the third (plus half-a-dozen lines each for two Integrated System Dynamics Models). This should be balanced out, and approximately the same amount of space devoted to each.	Thomas Brooks (TB)	This section has been edited to balance these descriptions - we have emphasized open access, documented models BR
120	5	20	19	20	34	I don’t understand why these four approaches are relegated to this 16-line Section 5.4.2.2 General Ecosystem Service Toolkits. All four are broadly comparable to	Thomas Brooks	These sections have been reorganized to

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						the three approaches covered in the previous section. I'd recommend merging these two sections, and balancing out coverage of the nine tools accordingly.	(TB)	give better balance to different approaches.
121		Major comments				<p>The strong side of the submitted document is the overview of the ES models (section 5.4). This part of the manuscript is well written, focused, and contains some excellent insights. Unfortunately, other parts of the document is not equally strong.</p> <p>In particular, section 5.2 needs much work to be publishable. While there is nothing wrong with the contents in this section, it provides little in terms of insights. The short run-through of various aspects is too shallow to make (what I think are) the desired points. Moreover, it reads poorly and is periodically quite repetitive (I actually struggled to keep awake while reading this section). My suggestion for improving this section is to reduce the length of the general descriptions of the concepts, and instead provide some cited cases where the concepts are demonstrated. This would also provide readers with a different and more applied perspective on the various concepts and their use. These problems partly also pertain to section 5.3, but this section is shorter and actually reads better.</p> <p>The introduction should contain the following:</p> <ul style="list-style-type: none"> <li>• A short statement on the purpose of the chapter. This should be at the very start of the chapter together with a brief motivation.</li> <li>• At the end of the introductory section, provide a brief readers' guide to the rest of the chapter.</li> </ul>	Eirik Romstad (ER)	Section 5.2 has been re-written to address all concerns.
122		Minor comments				<p>The version I received to comment was not quite ready for submission. This obviously pertains to the last part of section 5.4, and section 5.5), which were incomplete. More troublesome is that a quick language wash before submission would have improved readability, and removed many of the linguistic errors, in particular the following types of errors:</p> <ul style="list-style-type: none"> <li>• Missing the indefinite article “a” for indefinite singular nouns. Here, it should be noted that in English indefinite singular nouns are used less frequently than in most other languages. This form is usually reserved for making a specific point, like “A critical issue is ....”</li> <li>• Mismatch singular/plural on nouns and verbs on the present tense. Sometimes the third person singular present tense “s” is missing on verbs, other times it is added where it has no place (in particular when numerous factors are listed, making this plural and not singular).</li> <li>• Excessive use of the passive form. Try to write in the active form. It increases readability and often results in shorter sentences. There are also quite many instances of very long sentences (spanning 3-4 lines). In these cases readability would be greatly improved if sentences are split.</li> </ul>	Eirik Romstad (ER)	<p>You saw first draft.</p> <p>The document has been re-written, but the writing will still be imperfect. We hope to have enough time to improve the clarity of the writing for the final draft.</p> <p>Thanks for the writing tips</p>
123		3	27	3	33	Present the five dimensions of the Millenium Ecosystem Assessment in separate bullets.	Eirik Romstad	Section 5.2 has been re-written

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							(ER)	
124		6	20	6	23	Nitrogen is usually not the main reason for reduced water quality in fresh water environments, phosphorus is. However, for marine ecosystems the claim made is correct on the harmful effects of nitrogen emissions/runoffs.	Eirik Romstad (ER)	We agree. This has been dropped. See revisions in section 5.2.
125		6	29	6	34	This passage reads extremely poorly. Instead of using a complicated term like “anthropogenic assets and wealth”, why not go to the heart of the problem – poverty. It is well that poverty forces people to make choices they otherwise may not have made, and that some of these choices have negative (long term) impacts on the environment.	Eirik Romstad (ER)	The passage has been re-written and unnecessary material dropped. Anthropogenic assets is a term from the IPBES conceptual framework and we have to use it.
126		7	17	7	24	Another instance where the main point could be made much clearer by more direct language.	Eirik Romstad (ER)	Revised- see section
127		8	16	8	20	Start this passage with the lake example (line 21), and then make the general claim.	Eirik Romstad (ER)	Done. The section has been re-written and restructured
128		12	37	12	39	The sentence starting with “Analyses will typically ...”, is vague. Again, start with the direct example in the ensuing lines, and then make the more general points.	Eirik Romstad (ER)	Done – have started with direct example as suggested.
129		General comments				The chapter presents a critical review of existing works on ecosystem modeling and proposes to enrich the models by incorporating socio-economic (human well-being) concerns. Three groups of models were presented and discussed: proxy-based models; process-based models; and Bayesian model, which is a hybrid of the two. The work-in-process is a good start, and could potentially yield a fine chapter. There are however a number of critical issues that the authors should address moving forward. My main concern is about clarity on ‘value addition’ of the chapter. The following are my specific comments: 1. The chapter discusses a number of existing socio-ecological models, and how changes in the structure and functions of ecosystems could impact the flow of services (or the value of services) under certain and uncertain conditions. The authors clearly emphasize the need to introduce and enrich the human well-being dimension of such models. Regrettably, they have failed to clearly spell in concrete terms out how they intend to do it. For example, according to the authors, proxy based models are simple, require less data, are transferable, but do not address socio-ecological feedback. Process based model are more realistic, capture dynamic processes, can include socio-ecological feedback, and are designed to replicate complex systems. But they are data intensive, require expert	Wisdom Akpalu (WA)	Response: 1 – The chapter is a review, not an instruction manual. Bayesian models are a hybrid approach & like all models they have strengths and weaknesses, which have been further elaborated in Section 5.4.1.3. 2 – specific models classified as proxy/process/hybrid in new Table comparing models. 3 – Optimisation is

Nr	Chapter/ Section	From page	From line	Till page	Till line	Comment	Reviewer Initials	Response
						<p>knowledge to run them, and are not transferable. Bayesian model explicitly models probability and bridges the gap between the two classes of models. Does the Bayesian model has any limitation? And perhaps the critical question here is whether or not the authors are interested in developing a hybrid model? If so, what are the features and the structure of such a model?</p> <p>2. It is unclear to me what the relationship between 5.4.1 and 5.4.2 is. In the opening paragraph of section 5.4.2, the authors wrote that “models of ecosystem services can be classified as proxy or processed based”. Please clarify whether each of the models presented is a Proxy-based, Process-Based, or a hybrid. For example, it is unclear whether or not InVEST is proxy-based, process-based or a hybrid.</p> <p>3. Perhaps a major concern is the lack of emphasis on “optimization” in designing a socio-ecological model. The models discussed are primary about supply of ecosystem services, with little consideration for the extent of flows that maximizes societal welfare.</p> <p>4. The authors seek to deepen our understanding of the relationship between humans and nature by linking ecosystem models with human well-being. I am, however, wondering how this is possible without putting together a framework that looks at both the demand and the supply sides of ecosystem services. Indeed, we cannot delink ecological systems and human needs.</p> <p>5. Uncertainties and non-convexities are common features of biophysical systems. However, due to the complexities presented when trying to develop a comprehensive model, abstractions are typically necessary. I am wondering how the authors intend to capture all the complexities in biophysical systems in a bio-economic framework to obtain close-form solutions that could easily inform policy.</p> <p>6. The chapter also touches on livelihood issues and the relative value that the poor and the rich place on ecosystem services. A proper modeling framework may involve welfare functions, which assign weights to segments of the population. There is however, little discussion on this in the chapter.</p> <p>7. A number of variables (e.g. manufactured capital, human capital, social capital, institutions, and globalization) are noted as essential in the interaction between ecological systems and human wellbeing. It is very important to present a comprehensive discussion on how each of these factors have been incorporated in the existing models, the limitations, and how your model intends to address them.</p>		<p>an important goal of economists, but rarely achievable in reality. We prefer not to focus on optimization therefore.</p> <p>4 – We agree that modeling demand is important. A surrogate for demand is the value (economic, non-economic) ascribed to ecosystem services by society. Modelling value is the focus of a different IPBES Deliverable.</p> <p>5 – Good point. We have a section on uncertainty, plus uncertainty features in other chapters of this report.</p> <p>6 – Again, good point; but mainly the focus of a different IPBES Deliverable.</p> <p>7 – Perhaps beyond the scope of this chapter (although Section 5.2.2 touch on these things) – maybe covered by the ‘Values’ IPBES Deliverable?</p>
130		24	17			What about other service and product flows, such as capture fisheries? Why restrict the economic data to land values, agricultural production and value?	Wisdom Akpalu	Good point – have added to the list. But

Nr	Chapter/ Section	From page	From line	Till page	Till line	Comment	Reviewer Initials	Response
							(WA)	<p>should be noted that this section was preliminary and incomplete when reviewed. - NC</p> <p>The chapter includes a substantial discussion of EcoSim which is perhaps the most widely used tool for fisheries related ES assessments and mentioned MIMES and several other systems/process models that assess these dynamics</p>
131		1	20	1	25	This can lead to confusion - which model is correct - or more believable. This complementarity does not come through.	Patrick O'Farrell (POF)	We have revised this section. We emphasized that no single model is correct in all possible contexts, but rather, the choice of models is context-dependent. Moreover, multiple models may yield more insights than single model and therefore in most cases may generate complementary findings.
132		2	5	2	10	This is a great section - however a figure that is an example of a model which captures these elements and drivers would be an extremely valuable addition - the IPBES framework figure doesn't do this and could in fact be removed.	Patrick O'Farrell (POF)	This section was revised. However, we need to retain the references to the IPBES framework, which is the core

Nr	Chapter/ Section	From page	From line	Till page	Till line	Comment	Reviewer Initials	Response
								framework for this document. The various elements of drivers are discussed in the current revised version and also elaborated in Chapter 1 and 4.
133		3	15	3	20	Material wealth is not an overall measure, it is a single measure with culturally determined importance.. This increase in highly variable between countries and regions.	Patrick O'Farrell (POF)	Section has been rewritten to include broader discussion
134		3	30	3	35	The work of Sen and his concept of capabilities are vaguely aligned with what is presented here, but I believe his capabilities are much more thought through should be included.	Patrick O'Farrell (POF)	This section has been revised to incorporate some of the reviewer's suggestion on Sen's thoughts on capabilities.
135		5	40	5	40	To differentiate from the section above - is it about the changes in these indirect drivers?	Patrick O'Farrell (POF)	Done
136		9	5	9	10	Expand so that what these are can be understood, like the others.	Patrick O'Farrell (POF)	We agreed. See revised draft
137		9	10	9	15	I believe that a number of papers exist contrasting different models and approaches.	Patrick O'Farrell (POF)	We agree. But the purpose of the section is to compare models and approaches.
138		10	25	10	30	Note this is an issue of scale and at this chapter is focussed at a national and regional level.	Patrick O'Farrell (POF)	We agree that the ecological context is more relevant at finer scales, but is still applicable to all scales. We note in the paragraph that follows that scale is an important aspect of decision making. - NC
139		10	35	10	35	biophysical scales ? - rather	Patrick O'Farrell	We have changed text to 'spatial

Nr	Chapter/ Section	From page	From line	Till page	Till line	Comment	Reviewer Initials	Response
							(POF)	scale', which covers 'biophysical' and 'geographical'. - NC
140		11	5	11	10	I cant see how these could possibly be two different assessments.	Patrick O'Farrell (POF)	They are not different assessments – they are components of each of the IPBES Regional/ Sub-regional Assessments - NC
141		11	20	11	20	So this is a global assessment...?	Patrick O'Farrell (POF)	No. Regional assessments will be unique to each region but follow a structure consistent across all regions. - NC
142		11	20	11	25	If these are your questions then grouping on regions doesn't make sense. Biomes or development status would make mores sense.	Patrick O'Farrell (POF)	This is a comment for IPBES. Not relevant to Chapter 5 authors. - NC
143		11	40	11	40	I don't hold with this argument. Local service global beneficery. Global service, local beneficiary na. else why don't we make all the island states pay us for not polluting.	Patrick O'Farrell (POF)	Policy responses are a lot more complex than the reviewer suggests, and may require a mix of polluter pays and beneficiary pays. The advantage of an ecosystem services approach is a better identification of those groups.
144		12	10	12	15	Poor sentence structure rephrase to: It is important to establish the relationship...	Patrick O'Farrell (POF)	Agree. Done.
145		12	30	12	30	In many context the term decision makers refers by default to government officials... suggested possible change sentence to " and well require the collective involvement of a highly diverse group consisting of many decision makers.	Patrick O'Farrell (POF)	Agree. Done.
146		13	5	13	5	You could explore the understanding an ecosystem services and its benefits and how this lead to planning management interventions and a change in policy. A	Patrick O'Farrell	Good point – we have added South

Nr	Chapter/ Section	From page	From line	Till page	Till line	Comment	Reviewer Initials	Response
						classic example of this is the Working for Water programme in South Africa, where the science of ES assessment led to management interventions and a new direction for policy development around restoration and job creation.	(POF)	Africa as an example. - NC
147		13	5	13	10	There seem to be too many subsections within this section - I would consider restructuring this section into 2 or 3 sections	Patrick O'Farrell (POF)	Done
148		13	20	13	20	I'm not so sure, there are countless cases of human demand driving species to extinction - like all our global fisheries, this demand for the resource leads us to developing models around MVP, quota take off limit setting. Here demand is matched to upper limits and additional demand shifts to other sources of protein.	Patrick O'Farrell (POF)	Hope this is clarified in section - feel both comment and text are correct. Comment true but only one of all models does that
149		16	25	16	30	This sentence is not clear	Patrick O'Farrell (POF)	Fixed
150		16	40	16	40	This section should be trimmed down, weighting and content for comparisons between these different modelling approaches	Patrick O'Farrell (POF)	Invest section was trimmed as recommended
151		17	5	17	5	Models are mostly raster calculations	Patrick O'Farrell (POF)	mostly true for land not for aquatic
152		17	5	17	10	I don't agree, most of the models do not consider beneficiaries in any detail, they are really supply side models!	Patrick O'Farrell (POF)	Edited for clarity-
153		17	10	17	15	I disagree - Invest models have multiple input requirements, all the information that goes into these models needs to be provided by the user. Any often this information does not exist. Scenario testing is not well integrated into the suite of models. Documentation only covers the basics.	Patrick O'Farrell (POF)	Edited for clarity
154		17	40	17	40	However this tool requires a high level of skill and is not easy to manipulate in workshop environments by participants.	Patrick O'Farrell (POF)	This is now noted in the text
155		18	10	18	15	too much information.	Patrick O'Farrell (POF)	Text was edited down
156		18	30	18	30	It seems clear that this section has not been written by someone who has an understanding of ARIES. This section needs to be completely rewritten	Patrick O'Farrell (POF)	ARIES section was rewritten
157		18	30	18	35	No it is not widely used, the user community is very small, requires extensive training, complex, and users have to be registered and licenses to use the tool by an administrator.	Patrick O'Farrell (POF)	ARIES section was rewritten

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						8 services - no - any service can be modelled.		
158		18	35	18	40	The strenght of this approach is that beneficiaries are explicitly captured. Three individuals models relating to provisioning, beneficeries and the flow of the services are constructed. With probalistic models being used within this each of these models. Users don't haveto supply all the required data, the system will assist in locating appropriate datasets, based on the context and the semantics used.	Patrick O'Farrell (POF)	ARIES section was rewritten
159		19	25	19	30	I don't know this model, but is seems like this justification for its selection is needed up front.	Patrick O'Farrell (POF)	section 5.4.2.2 is reorganized
160		20	25	20	30	This modeling platform should be raised to the level above. It is not like those listed here and it is nore widely used than ecopath from my understanding.	Patrick O'Farrell (POF)	Done – we have removed the classification into the three operational categories
161		21	20	21	20	I don't this these are other but are components of the previous... This should be (if desired) moved up to the general ecosystem service tool kits. It is a rapid ecosystem assessment approach that uses proxy and/or process based models associates these with land-use. Uses expert opinion to determine proportional shifts in services associated with land use change. Simple spread sheet scenario can be developed and made spatially explicit based on land cover change. See ecology and society <a href="http://dx.doi.org/10.5751/ES-04886-170327">http://dx.doi.org/10.5751/ES-04886-170327</a>	Patrick O'Farrell (POF)	Agree. Have re-labeled these as 'proxy approaches'
162		21	30	21	30	The order of section could be improved, I would have this section and the next one before the discussion on the types of modeling approaches as they deal with Why model type questions.	Patrick O'Farrell (POF)	This section is completely revised and now mentions specific model, so its order after model descriptions is appropriate
163		22	5	22	5	Table 5.1: multiple different time periods	Patrick O'Farrell (POF)	table revised
164		22	10	22	20	This seems to relate to the decision contexts in 5.3 - is this not repetitivee, seems like there are structure issues here.	Patrick O'Farrell (POF)	Agree – have rewritten this section
165		23	10	23	10	Dealing with uncertainty is such a huge issue< I would consider having this as a seperate section not a subsection.	Patrick O'Farrell (POF)	Good point – have elevated to own section
166		3	15	3	20	Need to rectify these two statements better: HWB is increasing while biodviersity is declining. So we need to understand things better to avoid more biodiversity decline and the resulting loss of HWB. This is a key and big point – if they have been uncouple so far, why do we think BES and HWB will be coupled in future?	Taylor H. Ricketts (THR)	Added discussion on environmentalist's paradox to address this point

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						Answer is about distribution, vulnerable populations, focusing on those who rely most on BES as inputs to HWB.		
167		3	1	4	20	This section could use a nice clear conceptual diagram that is IPBES view on how BES and HWB are related. MA had one, which is dated now, but it was very useful at the time.	Taylor H. Ricketts (THR)	have to use IPBES framework - will consider adding figure of ES->HWB (space issues)
168		4	25	5	35	Mixing terms like assets and capital and infrastructure and technology. I would suggest adopting the widely used "4 capitals" framework of built, natural, social, human capital. Perhaps adding financial capital to make that distinction clear. All the other concepts in this section can be summarized within this established framework. Also, anthropogenic asset is a very clunky and opaque term.	Taylor H. Ricketts (THR)	Done in the broad revisions.
169		5	37			This section also needs a figure or table, listing out the drivers and showing which are anthropogenic and which are natural. Will help reader see the full list, instead of picking them out of text.	Taylor H. Ricketts (THR)	This should be done in chapter 3
170		5	37	7	15	Many very important references are missing from this explanation of drivers. Make sure you are picking the most central and influential and clear studies to cite in describing each of these drivers.	Taylor H. Ricketts (THR)	We have tried to pick some key references, though there is a forest of the same.
171		7	18	7	28	Section on natural drivers needs to be fleshed out much more, similarly to the one on anthropogenic drivers	Taylor H. Ricketts (THR)	This has been done
172		9	6	9	16	This paragraph is out of place. Move it to the major section on types of models. Actually, much of the content of section 5.2.4 does not fit the actual title of that section, which is about interactions, thresholds, etc. Diverse knowledge, and biodiversity indices don't fit here. Both are important topics, but seem out of place here.	Taylor H. Ricketts (THR)	We agree. This has been done
173		11	25	13	5	Also need to make sure citing a range of important work in this area. Seem to be currently just a few "go to" citations that keep getting referenced for multiple points. In this section, work by Polasky, 2011 book by Kareiva et al, papers by Bateman, Balmford, Reyers, Egoh, Fisher, Naidoo, and others will be important. Marginal value paper by Ricketts 2013 also helpful here. Whole issues of PNAS (2008) and Frontiers in Ecology and Evolution (2009) also helpful.	Taylor H. Ricketts (THR)	Added ref to Karevia; we have tried to improve and diversity referencing of the chapter
174		13	10	16	25	This categorization of model attributes wasn't clear or helpful to me, for several reasons. First, the ideas of proxy models and benefit transfer models is conflated. By proxy do you mean simply look-up tables of values for each type of landcover? One can use proxies within process based models too, so I don't think "proxy" is a good distinguishing feature of this type of modeling. Also, process modeling can range from simple production functions linking general attributes like land cover and a few parameters to ecosystem service production, all the way to very mechanistic models where the growth of each tree and the fate of nutrients	Taylor H. Ricketts (THR)	We thank the reviewer for their suggestions. We think the proxy/process categorization holds and is intuitive for readers. The series

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						adn water is tracked among species and guilds. The middle ground section isn't really a hybrid between these two categories either. It's only "middle" in that it's probably medium complex. What's distinguishing here is the use of expert knowledge. My list of attributes would be a serious of dichotomies: benefits transfer or production/value function; simple of complex processes modeled; empirical or expert-derived data; spatially explicit or not; temporally dynamic or not; biophysical or economic (benefit) outputs. Models could occupy probably all combinations of these pairs of attributes. A table depicting that would help.		of dichotomies are now (somewhat) captured by our section on decision contexts and model selection (Section. 5.3)
175		16	27			This section isn't about types of ES models. It is about existing tools, really - the different packages that have been developed to help people support decisions. You should change the section title to reflect that, and to distinguish it from previous section, which is (should be) instead about the model types per se. (see previous comment)	Taylor H. Ricketts (THR)	Agree – have dropped the word 'type' from the section heading -
176		17	1	18	30	Other citations for InVEST include Kareiva 2011 Cambridge Press, Arkema 2014 Envir Research Letters, adn Bhagabati 2014 Biol Cons. Each show the range of uses InVEST can be put to, and the kareiva book is the best single source for the types of models and approach included.	Taylor H. Ricketts (THR)	we now cite Karieva book
177		21	5	21	8	Another green accounting approach, the Genuine Progress Indicator, should also be reviewed here. It modifies GDP to account for gain/loss in natural capital and ecosystem service (among other things that GDP ignores). Has been applied to several US states and several countries worldwide.	Taylor H. Ricketts (THR)	Agree – have added GPI as example of green accounting NC
178		22	10	23	10	This section (5.4.3) is really important, and will be very helpful to readers and leaders as they decide how to pursue a BES analysis for HWB. Showing how simple models can actually inform complicated decisions is crucial. Examples that come to mind are in Belize (Arkema 2014), Indonesia (Bhagabati 2014), Canada (Guerry paper already cited). Beneficiaries point is a critical one too. Papers that illustrate how important this is include Arkema 2013 Nature Climate Change, Ricketts and Lonsdorf 2013 Ecological Applications, Costanza et al 2008 Ambio, and Bateman et al. 2013 Science.	Taylor H. Ricketts (THR)	Point noted