

#	Ch	From Page	From Line	To Page	To Line	Comment
1	6	0	0	0	0	Since the chapter involves so many terminologies and their short forms, it might be useful to add an index for these terms as this approach will be helpful for the readers (probably at the beginning of the chapter). (Ambulkar, Archis, Brinjac Engineering Inc.)
2	6	0	0	0	0	IOC-UNESCO, 2011. Methodology for the GEF Transboundary Waters Assessment Programme. Volume 6. Methodology for the Assessment of the Open Ocean, UNEP, vi + 71 pp. (Diop, Salif, UNEP - SAB - DEWA)
3	6	0	0	0	0	References: Gregg et al. (2005) see refs for Chapter 30/ Head, E.J.H., Pepin, P. (2010) Monitoring changes in phytoplankton abundance and composition in the Northwest Atlantic: a comparison of results obtained by continuous plankton recorder sampling and colour satellite imagery. J. Plank. Res. 32, 1649-1660 / McQuatters et al. (2011) see refs Chapter 6 / Richardson, A. J., Shoeman, D.S. (2004) Climate impact on plankton ecosystems in the Northeast Atlantic. Science. 305, 1609-1612/ Saba et al. (2010) see refs for Chapter 6/ Vantrepotte and Melin (2011) see refs for Chapter 30 (Head, Erica, Fisheries and Oceans Canada)
4	6	0	0	0	0	Chapter 6 is evolving very well. The coverage is extensive and, from my perspective, essentially complete. The tables and figures summarize a vast amount of information. The tables and some figures have a high "density" but for those willing to dig into the information that's provided, most of the relevant information is likely to be discovered. The literature cited covers the wide array of topics exceptionally well. I suggest an additional paper below, but hesitate to recommend adding too many more references unless they offer something novel and important (and the recent paper I recommend citing appears to do). The quality of the writing is quite variable, in my opinion. In part, this variation in quality/style reflects the large number of "cooks" in the "kitchen." The Executive Summary is extremely well done. It presents the key findings with clarity and in a concise, user-friendly manner that should make this important part of the chapter easily accessible to all readers, even those who do not bring a high level of scientific expertise to the document. Other sections of the report are a bit dense and provide more detail than is probably necessary. However, it's probably better to err on the side of providing depth and detail than making things too simple/simplistic. There are redundancies throughout the chapter, notably in the introductory sentence/paragraphs of the different sections where we are continually reminded that temperature, OA, etc. have impacts on marine ecosystems across all levels of biological organization. This type of redundancy helps to make the separate sections more "stand alone" documents in terms of providing introductory background material, but I would suggest that the next editing step involve pruning some of these redundant sections to make the chapter less repetitious. Although not requested to do so, I have called-out a few typographical/grammatical issues with the intent of helping out on the fine-details of the editing. (Somero , George , Stanford University)
5	6	0	0	0	0	I found the chapter well written and clear to an "outsider". - One complaint is the use (offuse?) of OA for ocean acification and in one place I saw OAE for ocean acidification effect. I recommend always spelling these out. The translation got me many time in reading the chapter. (Stouffer, Ronald, Geophysical Fluid Dynamics Laboratory/NOAA)
6	6	0	0	0	0	In order to reflect contributions made by developing countries in the aspect of climate change adaption, it is suggested to increase the adaptive policymaking and measures of adaptive policy and measures of the oceanic system in China incorporated in "The Second National Assessment of Climate Change which was adopted as the formal reference literature. (Duan, Juqi, National Climate Center, Chinese Meteorological Administration)
7	6	0	0	0	0	This Chapter assembles an incredible amount of information. I found, however, the presentation to be very dense, often making understanding and interpretation of the assessments extremely difficult. I think it requires a clear editorial hand to make it much more accessible to readers. (Lough, Janice, Australian Institute of Marine Science)

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8	6	0	0	0	0	As the Ocean System Chapter, in contrast to the regional ocean (CH 30 Open Ocean), it would have suited to organize the chapter with a main structure along two axes: 1) from bottom of the food web to the top and 2) on the general processes linked to the water column from surface processes to the deep-sea dynamics of benthos, i.e. the vertical changes through the ocean water column. The vertical changes in the ocean, physically, chemically as well as linked to the ecosystem components are generic issues that would have suited well in the Ocean System chapter. (Sundby, Svein, Institute of Marine Research)
9	6	0	0	0	0	This chapter stands out as being particularly poorly written. The sentences are extremely long (often as long as whole paragraphs), the language very technical, the grammar is poor and it is often hard to understand what a paragraph's main point is. More of a narrative for this chapter would be useful - see Chapters 28 or 30 for examples of well written, narrative driven chapters. This chapter contained a wealth of up to date and relevant information, however it was difficult to read and understand. Paragraphs are sometimes too full of observations and have too little interpretation of their meaning for the bigger picture. Sometimes, the conclusions of paragraphs are unexpected based on what was discussed at the start of the paragraph. The structure of the chapter as a whole could also be confusing at times - there seems to be repetition of some information throughout the chapter with a slightly different angle each time. It would also be useful if key terms, such as 'ectotherms' vs 'endotherms', 'populations' vs 'species', 'communities' etc. were defined earlier in the chapter. The chapter would benefit from a simpler style and structure to help highlight key points. The FAQs and the box on coral reefs at the end of the chapter provide better examples of a simpler writing style. (AUSTRALIA)
10	6	0	0	0	0	There needs to be a statement at the start of this chapter which makes it clear as to exactly what oceans information chapter 6 and chapter 30 cover and how they differ from each other. There seems to be duplicated information between the chapters. (AUSTRALIA)
11	6	0	0	0	0	The overall structure of the chapter is hard to follow, it seems to jump around a lot. For example, ocean acidification is discussed under sections 6.1.1.2, 6.2.2.2, 6.2.3.4, 6.2.4, 6.2.5.3, and 6.3.4. This results in confusion and duplication of the same information. The chapter would benefit from a clear narrative and more easy to follow structure. (AUSTRALIA)
12	6	0	0	0	0	Chapter 6 provides a comprehensive account of climate-related (physico-chemical) changes in the ocean and their potential effects on marine organisms. For a single chapter, it seems overlong (at 161 pages in this format). Thus it would benefit from editing to reduce internal repetition and unnecessary detail on some aspects; it should provide a focussed assessment, not an introductory text book on biological oceanography. Table 6.2 (p 125) provides an example of material that is 'interesting background', but not essential, whilst Sections 6.5 and 6.6 seem to repeat - in some detail - material that has already been presented. More crucially, overlap with Chapter 30 should be minimised, with scope for much of the material of a 'regional' nature to be moved there. Examples include: Fig 6.11 (legend p 29; figure itself p 150-151); Table 6.1 (p 124-5), Table 6.3 (p 126), and Table 6.8 (p 133). (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
13	6	0	0	0	0	Bioinvasion in relation to climate change has not been dealt (INDIA)
14	6	0	0	0	0	Please shorten and simplify the FAQs in this chapter and use a style similar to the other chapter. (GERMANY)
15	6	0	0	0	0	The pelagic fish species seems to adapt quite fast to the changes in climate by changing their distribution and migration patterns. Atlantic mackerel is not only a good example, it is also of great ecological and economical importance. Also, the changes in distribution has received quite a lot of attention within the last decade. Therefore, I suggest to add this species as an example. (Jansen, Teunis, Danish Technical University - National Institute of Aquatic Resources)

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16	6	0	0	0	0	Chapter 6 is uneven in the depth to which it covers various topics. It has a scholarly and very thorough examination of the potential constraints on adaptation imposed by physiology. It also gives a thorough review of lower trophic levels (through phytoplankton) in the sea. It is weak in its coverage of zooplankton, and also very weak in its coverage of fish, turtles, birds, and mammals. It barely touches on the role of sea ice in the recruitment of krill in the Antarctic, and seems to miss these issues completely for both krill and copepods in Arctic waters, including the Bering Sea. I realize that these issues are covered to some extent in the Regional Chapter 28 on polar regions, but these issues should also be raised in this chapter as, especially in the case of the Bering Sea, it does not fall under the IPCC definition of the Arctic. It seems to me that this chapter, at least in part, should pull forward the most telling points from the regional chapters so that one can see where problems are similar or unique. That said, there seems to be a fair bit of repetition within Chapter 6. And, some sections seemed hard to read. Perhaps more commas after introductory clauses would help. Within the sections on physiology, there seemed to be little attention played to the role of temperature on raising metabolic rates with the potential consequence of exhausting lipid stores before the next season's production was available. This applies to over-wintering juvenile fishes, copepods in diapause, euphausiids, etc. (Hunt, George, University of Washington)
17	6	0	0	0	0	Finally, regarding chapter 30, I could not find any connection with chapter 6. These two chapters are closely related. I hope good organization between them. (Ito, Shin-ichi, Fisheries Research Agency, Tohoku National Fisheries Research Institute)
18	6	0	0	0	0	Chapters 6 and 30 must be coordinated! There is far too much overlap. E.g., 30.3 and 6.1.1 address the same general issues. Box 6-1 is a regional example, duplicating information in Chapter 30. (Ottersen, Geir, Institute of Marine Research)
19	6	0	0	0	0	To avoid confusion with chapter 30 ("The Ocean") this chapter should be named "Ocean Eco-Systems". (NETHERLANDS)
20	6	0	0	0	0	Again, we have the textbook summary that we know something about some things (e.g., specific responses are attributable to climate change) but we aren't told what those are specifically. The text is more conceptual rather than a focused summary on the best known information. What are the main physiological responses of microorganisms to climate change? (UNITED STATES OF AMERICA)
21	6	0	0	0	0	Can the first time RCP is spelled out it be given a simple definition? The name is not intuitive. "The representative concentration pathways, or greenhouse gas concentration trajectories." I realize this is in other chapters and is a fundamental IPCC definition, but for utility of stand alone chapters, this would be nice. (UNITED STATES OF AMERICA)
22	6	0	0	0	0	Ch 6 missed the mark in terms of providing concise summaries that highlight the main information from recent literature and instead provided quite general statements. The style of Ch 30 tends to be much more informative and much easier to read. (UNITED STATES OF AMERICA)
23	6	0	0	0	0	Chapter 6 never discusses sea level rise. Why? This seems an important omission. (UNITED STATES OF AMERICA)
24	6	0	0	0	0	Considering the chapter's length, number of topics and many references, there are relatively few figures, many are schematic diagrams, and few quantitative data presented in the figures. The chapter is extremely descriptive [including the long lists of things in the tables]. By covering so many diverse and sometimes peripheral topics [some legitimate environmental concerns, but not directly climate-related], this seems to detract from the coverage of the 3 or 4 main ocean issues related to climate change. (UNITED STATES OF AMERICA)
25	6	0	0	0	0	Data sets of organisms with life histories of decades and centuries cannot be found here or in 6.3.2 ??? (UNITED STATES OF AMERICA)

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26	6	0	0	0	0	Here and elsewhere in the Chapter, the authors point that "Temperature defines the geographic distribution of species and their resources..." is not the complete story. It also is inconsistent with other sections of the Chapter. For example, the shoaling of hypoxic (6.3.3) or corrosive (6.3.4) water may reduce their distribution. Other physical and biological climate impacts, such as circulation or primary productivity, may be indirectly tied to temperature, but in a complex way that is not the intent of this statement. An elaboration or clarification is necessary in the Executive Summary. (UNITED STATES OF AMERICA)
27	6	0	0	0	0	In both Chapters 6 & 30, the use of confidence and likelihood statements is inconsistent within and between chapters. There are some sections in which confidence or likelihood statements are included after almost every sentence, and in other areas there are entire chapter sections without a single confidence statement. In some cases there is evidence of statistical confidence (for example p values are listed) however a confidence statement is applied instead of a likelihood statement. In general, for many of the statements including information on chemical concentrations or physical properties of ocean systems, likelihood statements can and should be applied; for many of the biological observations, it is more difficult to apply likelihood statements, and in these cases, confidence statements should be used. There are also instances in which the wrong language is used in a confidence statement (e.g. moderate confidence instead of medium confidence, etc.). (UNITED STATES OF AMERICA)
28	6	0	0	0	0	Overall how does the marine interpretation of risk and confidence levels compare to assessment in chapters on terrestrial systems? Is anyone doing those comparisons? (UNITED STATES OF AMERICA)
29	6	0	0	0	0	Please make % of earth covered by water consistent, 71 vs 70% given on 2 pages. (UNITED STATES OF AMERICA)
30	6	0	0	0	0	Provide a clear and concise definition of microbes. Microbes appear to be interchangeably used with the term bacteria while in text three slightly different criteria are used: page 4, line 38, "Microbes (Bacteria, Archaea, unicellular algae and protozoans)"; page 14, line 42, "Microbes, i.e. bacteria and microalgae; page 52, line 7, "microbes are archaea, bacteria and protists including phytoplankton" (UNITED STATES OF AMERICA)
31	6	0	0	0	0	References to historical change in chapter 6 are inconsistent. This instance says CO2 change is "unprecedented" other places in chapter say not in X years, but X is not consistent. This needs to be checked very carefully. (UNITED STATES OF AMERICA)
32	6	0	0	0	0	The authors should consider listing a table to express confidence & likelihood in processes and minimize listing them in parenthesis in text. The text is difficult to read as is. (UNITED STATES OF AMERICA)
33	6	0	0	0	0	The chapter is uneven in scope and level of complexity. Some thought needs to be given as to the target audience. The readability of the chapter is difficult due to the reiteration of topics and issues. For example, there are 6 different sections on warming/temperature, 6 different sections that address ocean acidification, and 5 different sections on hypoxia. The division of each of these topics into different sections makes the chapter seem disjointed and difficult to read. The authors should consider reorganizing the chapter to minimize repetition of sections and improve flow of information. (UNITED STATES OF AMERICA)
34	6	0	0	0	0	The conclusions for subsections should be eliminated to improve flow ease of reading. The executive summary and final conclusions are sufficient. (UNITED STATES OF AMERICA)

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35	6	0	0	0	0	The repetition between chapters 6 and 30 also carries over into the executive summaries of both chapters. In some cases, where material is repetitive, the statements seem contradictory, and some of these have been pointed out in individual review comments. Since the Executive Summaries may be the only sections that are read by many readers, it is imperative that the space and content be used efficiently to relay the most important issues. It is recommended that Executive Summary statements be limited to generalized statements regarding the state of the ocean and global impacts in Chapter 6, while Chapter 30 Executive Summary should focus on the regional differences in climate change impacts as is summarized in Figure 30-15. It is also recommended that the authors of chapters 6 and 30 review both of these chapters, and relevant sections of the WGI document to minimize unnecessary redundancy and insure consistency of both factual information and use of confidence and likelihood statements. (UNITED STATES OF AMERICA)
36	6	0	0	0	0	There are many missing key published references on biota effects, for example: Allgaier et al 2008; Andersson et al 2003; Attrill & Edwards 2008; Baumann et al 2012; Beardall and Raven 2004; Beardall et al 2009; Beer & Koch 1996; Borchard et al 2011; Chan et al 2008 (see many others summarized in https://fortress.wa.gov/ecy/publications/publications/1201016.pdf (UNITED STATES OF AMERICA)
37	6	0	0	0	0	There are some sections in which confidence or likelihood statements are included after almost every sentence, and in other areas there are entire chapter sections without a single confidence statement. In some cases there is evidence of statistical confidence (for example p values are listed) however a confidence statement is applied instead of a likelihood statement. In general, for many of the statements including information on chemical concentrations or physical properties of ocean systems, likelihood statements can and should be applied; for many of the biological observations, it is more difficult to apply likelihood statements, and in these cases, confidence statements should be used. There are also instances in which the wrong language is used in a confidence statement (e.g. moderate confidence instead of medium confidence, etc.). It is recommended that the authors review the content throughout the document for compliance with IPCC rules for applying confidence and likelihood statements. (UNITED STATES OF AMERICA)
38	6	0	0	0	0	There is a tendency to make statements of speculation rather than to focus on just facts, and as such, the text seems a bit "jargony" in places as compared to chapters in WGI. Where outcomes or information is unknown, especially in predicting future conditions, then discussion should be limited to only facts and data for which confidence statements can be made. There is some concern that speculation statements may lead to misuse of content, and this should be avoided where possible. (UNITED STATES OF AMERICA)
39	6	0	0	0	0	There is considerable repetition of material between chapters 6 and 30. It is understood that these chapters should be readable as stand-alone. However, clear statements should be made in the introductions on the objective of each chapter, the need to review some fundamental concepts for an understanding of the chapter material, and the differences between chapters 6 and 30. (UNITED STATES OF AMERICA)
40	6	0	0	0	0	There seems to be a tendency in both chapters 6 & 30 to make statements of speculation rather than to focus on just facts, and as such, the text seems a bit "jargony" in places as compared to chapters in WGI. It is also recommended that the authors of chapters 6 and 30 review both of these chapters, and relevant sections of the WGI document to minimize unnecessary redundancy and insure consistency of both factual information and use of confidence and likelihood statements. (UNITED STATES OF AMERICA)
41	6	0	0	0	0	This same statement applies for ocean acidification. (UNITED STATES OF AMERICA)
42	6	0	0	0	0	This section and perhaps others mis-use temperature for density. The MLD is function of both temp and salinity. While open ocean may be mostly temperature defined for its density structure this is not true for many pelagic parts of the ocean as discussed in this chapter. (UNITED STATES OF AMERICA)
43	6	0	0	0	0	To ensure consistency, chapter 6 authors should review chapter 30 and vice versa (UNITED STATES OF AMERICA)

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44	6	0	0	0	0	We recognize and appreciate the increased emphasis on oceans in AR5. However, Chapters 6 and 30 are so interrelated and overlapping that we suggest that the IPCC consider combining them in future assessments; this would improve readability and reduce redundancy. For example, warming, acidification and hypoxia are addressed multiple times between the two chapters. We suggest that these chapters be shortened by replacing redundancies with cross-references. In addition, the chapters should be more carefully scrubbed for inconsistencies. Both of these goals could be accomplished by having the author teams read both chapters. the first 20 pages of Ch 30 belong in Ch 6 (and can in large part be merged with existing text in Ch 6). The focus on regional impacts in Ch 30 is lost due to repetition of technical foundation that should be in Ch 6. (UNITED STATES OF AMERICA)
45	6	0	0	0	0	Whenever possible a quantitative likelihood scale should be used rather than the qualitative confidence scale. (UNITED STATES OF AMERICA)
46	6	0	0	0	0	Figure 6-15: Please use equal size classes above and below zero. For example, why do the first classes span 9 % in positive but 14% in negative direction? (Rock, Joachim, Johann Heinrich von Thuenen-Institute, Federal Research Institute for Rural Areas, Forestry and Fisheries)
47	6	0	0	0	0	This is generally an excellent chapter that is well written and researched. Each assessment of confidence is well supported by evidence although there is some overlap with Chapter 30. The two chapters seem to have been written by completely different teams of authors who clearly have not spoken to one another. There are few cross-references in each chapter and several contradictions in both evidence and confidence assessments (see comments regarding chapter 30) . (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
48	6	0	0	0	0	I strongly suggest to spell out "OA" as "ocean acidification". It provides a better reading experience. (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
49	6	0	0	0	0	The structure of this chapter does not provide a pleasant reading experience because the biological impacts of climate change are split in two different section (6.2 and 6.3). The rationale for doing that seems to be to distinguish lab and field evidence. I think that it would be much better to a a single location of the biological impacts, whether studied in the lab or in the field. It would also limit duplication (see the coverage of nitrogen fixation which appears at least twice and cites similar papers). (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
50	6	0	0	0	0	There are some missing/ incorrect citations in the chapter. These discrepancies have been highlighted in the ref check document for chapter 6 and is available in the supporting material web page. Chapter team may wish to rectify these errors before starting to work on SOD revisions and FGD preparation. (Chatterjee, Monalisa, IPCC WGII TSU)
51	6	0	0	0	0	1) Overall -- This chapter team has developed a robust, compelling 2nd-order draft. In the final draft, the chapter team is encouraged to continue its prioritization of effective figures, rigorous assessment, high specificity, and clear writing. (Mach, Katharine, IPCC WGII TSU)
52	6	0	0	0	0	2) Coordination across Working Group II -- In developing the final draft of the chapter, the author team should continue to ensure coordinated assessment, both in the chapter text and at the level of key findings. Such coordination is relevant across many of the sectoral and regional chapters, but especially across chapters 5, 6, and 30. Where cross-references are made to other chapters, they should preferably cross-referenced specific sections and/or assessment findings of the chapters, continuing to ensure that overlaps are reduced and assessment harmonized. (Mach, Katharine, IPCC WGII TSU)
53	6	0	0	0	0	3) Harmonization with the Working Group I contribution to the AR5 -- In developing the final draft, the chapter team should also ensure all cross-references to the Working Group I contribution are updated, with discussion of climate, climate change, and climate extremes referencing the assessment findings in that volume. Where cross-references are made, wherever possible and appropriate they should specify the specific relevant sections of Working Group I chapters, instead of generic references to whole chapters. (Mach, Katharine, IPCC WGII TSU)

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54	6	0	0	0	0	4) Shortening and tightening the chapter -- The chapter team is strongly encouraged to shorten the text of the chapter as much as possible, ideally by at least 10 pages. Paragraphs providing "textbook-like" background information should be particularly targeted. The traction of the chapter will be greatest if the reader is sucked into the assessment and its emerging narrative, without encountering an extraneous word; the reader should never have a sense of plodding through material removed from cutting-edge assessment of current understanding. (Mach, Katharine, IPCC WGII TSU)
55	6	0	0	0	0	5) Presentation of uncertainty language within parentheses -- As much as possible, the chapter team should present calibrated uncertainty language within parentheses at the end of sentences. Such placement maximizes the directness and clarity of statements. Wherever possible, formulations such as "there is high confidence that" should be nixed and replaced by "(high confidence)" at the end of the sentence. (Mach, Katharine, IPCC WGII TSU)
56	6	0	0	0	0	6) Report release -- The chapter team should be aware that the final drafts of the chapters will be posted publicly at the time of the SPM approval, before final copyediting has occurred. Thus, the chapter team is encouraged to continue its careful attention to refined syntax and perfected referencing. (Mach, Katharine, IPCC WGII TSU)
57	6	0	0	0	0	7) Characterization of future risks -- In characterizing future risks for ocean systems, to the degree appropriate the chapter team should indicate the extent to which risks (or key risks) can be reduced through mitigation, adaptation, and other responses. In discussing evolutionary adaptation or ecological shifts versus human responses and adaptation affecting ocean systems, clarity should be ensured. If possible, the chapter team should communicate how risks may increase as the level of climate change increases or, potentially, the relative importance of changes in mean conditions, as compared to changes in extreme events, as compared to potential non-linear changes associated with biome shifts or tipping points. Building from this, how much can risks be reduced through adaptation or other management approaches, in the near-term and the long-term? How are factors or stressors that multiply risks relevant in this context? As supported by its assessment of the literature, the author team should consider communicating risks for the era of climate responsibility (the next few decades, for which projected temperatures do not vary substantially across socioeconomic/climate scenarios) and for the era of climate options (the 2nd half of the 21st century and beyond). As would be helpful to the chapter, the framing of table SPM.4 could be considered in characterization of future risks, along with the key and emergent risk typology of chapter 19. (Mach, Katharine, IPCC WGII TSU)
58	6	0	0	0	0	8) Informing the summary products -- To further support robust and insightful summary products for the report, the chapter team is encouraged to maximize nuance as well as traceability in its key findings, continuing to use calibrated uncertainty language effectively. In addition to nuanced characterization of future risks (see the previous comment), the chapter team is encouraged to consider themes emerging across chapters, indicating for example how extreme events pose risks for ocean systems, how limits to adaptation may be relevant in the context of this chapter, and how interactions among mitigation and adaptation may occur. (Mach, Katharine, IPCC WGII TSU)
59	6	0	0	0	0	GENERAL COMMENTS: I congratulate the author team for all their work on an interesting and informative SOD. When considering the suite of review comments, please look for opportunities to continue to hone and focus the text in revision even further, reducing length wherever possible. Please see my detailed comments for suggestions related to specificity of ES findings, traceable accounts, and specific clarifications. (Mastrandrea, Michael, IPCC WGII TSU)

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60	6	0	0	0	0	SUMMARY PRODUCTS: In preparing the final draft of your chapter and particularly your executive summary, please consider the ways in which your chapter material has been incorporated into the draft SPM and TS. For Chapter 6, this includes presentation of observed impacts and vulnerabilities in section A.i, sectoral and regional risks in section C.i, and interactions between adaptation and mitigation in section D.ii, as well as related figures and tables. Are there opportunities for presenting chapter findings and material in a way that further supports broad themes highlighted in the summary products and that facilitates additional cross-chapter synthesis in specific findings or figures/tables? Do the existing summary product drafts suggest additional coordination that should occur between Chapter 6 and other chapters at LAM4? (Mastrandrea, Michael, IPCC WGII TSU)
61	6	1	0	0	0	General Comment – Would a box on climate- overfishing interactions be worth using? (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
62	6	1	1	1	1	Chapters 6 (Ocean Systems) and 30 (The Oceans) have very similar titles - should differentiate based on content. For Ch 6, title should be more descriptive - The Oceans: Climate Change Impacts and Observations. Ch 30: The Oceans: Regional Differences in Impacts (for example). (UNITED STATES OF AMERICA)
63	6	1	1	24	123	The literature cited is inadequate. Climatically sensitive North Indian Ocean appears ignored. Although one acknowledges that Chapter 6 dealt with global ocean, in general, the scientific discussion appears to have been based on the contributed authors' works than on sensitive ecosystems elsewhere. For instance, Hans-O-Portner (Coordinating Lead Author of the Chapter 6) included 20 of his first authored papers (some more as not first author) while Philip Boyd included 10 references of his own (first author). The North Indian Ocean region, which is in close proximity to anthropogenic influence vulnerable to climate change perhaps more than many other regions in the world oceans, has been shown to contain the largest pool of seasonally occurring coastal hypoxia where the world's highest nitrous oxide concentrations in seawater were found. The Arabian Sea houses strong upwelling systems that are shown to have been warmed in recent times and aragonite saturation depth shallowed. On the other hand, stratification in the Bay of Bengal has been recognized to be significant with implications to generating extreme events. The intensity of extreme events have been shown to be on the rise which will have serious impact on the oceanic ecosystem and food production. The following references should be considered for inclusion in Chapter 6. Sensitive systems around the world be given due attention and research contributions from those regions be given due recognition. Naqvi, S.W.A.; Jayakumar, D.A.; Narvekar, P.V.; Naik, H.; Sarma, V.V.S.S.; DeSouza, W.; Joseph, S.; George, M.D Increased marine production of N2O due to intensifying anoxia on the Indian continental shelf Nature: 408(6810); 2000; 346-349. Sarma, V. V. S. S., Ono, T. and Saino, T. (2002) Increase of total alkalinity due to shoaling of aragonite saturation horizon in the Pacific and Indian Oceans: Influence of anthropogenic carbon inputs. Geophysical Research Letters, 29, 10.1029/2002GL015135. B. N. Goswami, V. Venugopal, D. Sengupta, M. S. Madhusoodanan, Prince K. Xavier Increasing Trend of Extreme Rain Events Over India in a Warming Environment Science 314, 1442 (2006); DOI: 10.1126/science.1132027 S. Prasanna Kumar, Raj P. Roshin, Jayu Narvekar, P.K. Dinesh Kumar, E. Vivekanandan Response of the Arabian Sea to global warming and associated regional climate shift Marine Environmental Research 68 (2009) 217–222 J Zhang, G Cowie and S W A Naqvi Hypoxia in the changing marine environment Environ. Res. Lett. 8 (2013) 015025 (3pp) doi:10.1088/1748-9326/8/1/015025 (INDIA)
64	6	2	13	2	13	Why a ? (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
65	6	3	0	0	0	General Comment – quite a bit of sloppy use of e.g. and i.e. throughout. (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
66	6	3	0	5	0	The Executive Summary needs to be simplified and made clearer. This is the section of the chapter that will be most widely read. Efforts need to be made to clearly capture the major points of the chapter and express them in an easy to read way. Bolded sentences in executive summary are often not the most important points of the chapter. (AUSTRALIA)

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67	6	3	17	0	0	Time Frame of Executive Summary Findings -- For all findings within the executive summary, the chapter team should carefully review verbs and sentence constructions used to ensure clarity of timeframe. For some statements, it is not completely clear whether the conclusion pertains to past observed outcomes, current observations, or future projections or expectations following from understanding of sensitivities. (Mach, Katharine, IPCC WGII TSU)
68	6	3	17	0	0	Parenthetical Presentation of Uncertainty Language -- The chapter team is encouraged to continue presenting calibrated uncertainty language parenthetically in the executive summary and also to explore options for further doing so. (Mach, Katharine, IPCC WGII TSU)
69	6	3	17	0	0	Characterizing Future Risks In the Executive Summary -- As much as possible, the chapter team should specify the degree to which future risks change or increase with increasing levels of climate change. Which risks emerge in the near-term, and which emerge in the long-term? What is the potential for reducing risks through adaptation and mitigation? And an obvious point that is nonetheless very important is that the chapter team should ensure that it clarifies the relevance of climate change in each key finding. (Mach, Katharine, IPCC WGII TSU)
70	6	3	17	0	0	Executive Summary: Please continue to refine the detail and clarity of the executive summary as you revise the chapter--I have made various specific suggestions along these lines below. For example, to the extent possible as supported by the literature, please emphasize what risks are projected to emerge over different time horizons (e.g., mid-century vs. end-of-century), as well as the potential or lack of potential for mitigation and adaptation to reduce them. Please also check and ensure clear line of sight to underlying chapter sections--in general please specify the specific subsections that provide support, rather than major sections, unless it is really the major section that is intended as support as a whole. I have also noted places where further clarity is needed in my specific comments. (Mastrandrea, Michael, IPCC WGII TSU)
71	6	3	19	3	24	The first sentences in bold of the first two paragraphs of the Executive Summary would seem to be statements of fact. Thus 'very high' confidence or 'virtually certain' (or even without any qualifier) would seem appropriate, rather than 'high confidence'. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
72	6	3	19	3	27	These two first paragraphs seem to be meant as an introduction to all the subsequent paragraphs. But I feel it is so generally formulated that they lose meaning. May be put the two together, rewrite and make it more obvious that it is an introduction to the main points to come. (Sundby, Svein, Institute of Marine Research)
73	6	3	19	5	38	Much of the material in the Executive Summaries of Chapters 6 and 30 is very repetitious. A side by side analysis of the content of each chapter makes the information seem confusing, especially with respect to confidence statements, and this could be perceived as contradictory. For example, Chapter 6, p5, L5-6 states that changes in water chemistry due to ocean acidification have been limited between the pre-industrial and today. However, Chapter 30, p3, L31-35 states that the increased uptake of CO2 has decreased pH and fundamentally changed ocean chemistry, and that the rate of change in water chemistry is unprecedented in millions of years. For those who are not experts, this seems like a contradictory statement. There are many examples of this throughout both Executive Summaries. It is recommended that repetitive statements be removed from the ES sections. Chapter 6 ES should focus on generalized statements regarding climate change impacts to the ocean as a whole. Chapter 30 ES should focus on statements regarding region specific impacts as exemplified in Figure 30-15. (UNITED STATES OF AMERICA)
74	6	3	20	3	20	It could be helpful to clarify that the findings here pertains to "ocean ecosystem services," rather than all ecosystem services. (Mach, Katharine, IPCC WGII TSU)
75	6	3	22	0	0	Remove "and" so that the sentence is "natural hazards, aesthetic, cultural..." (Ambulkar, Archis, Brinjac Engineering Inc.)

#	Ch	From Page	From Line	To Page	To Line	Comment
76	6	3	24	3	27	One potentially major impact to ocean chemistry resulting from temperature and ocean acidification is the availability of trace metals and trace metal uptake by biological organisms (e.g. Hoffman et al. 2012. Influence of ocean warming and acidification on trace metal biogeochemistry. Marine Ecology Progress Series 470:191-205). This should be addressed in the relevant section (6.1.1) (UNITED STATES OF AMERICA)
77	6	3	27	0	0	I suggest to introduce composition in the phrase: to ecosystem composition, structure and function. Probably one of the more rapid signal of responses of the biota was change in composition. Also, some structural index can be very similar but with a very different composition (Anadon, Ricardo, University of Oviedo)
78	6	3	27	3	27	delete "function" and insert "functioning" (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
79	6	3	29	3	29	As a minor point, "have been" feels more appropriate here to me, rather than "were." (Mach, Katharine, IPCC WGII TSU)
80	6	3	29	3	34	The "very high confidence" assignment in the statement that "Marine ecosystems were and are being exposed to and affected by climate change of different rates, magnitude and duration" is not supported by the confidence of individual supporting evidence in sections 6.1.2 and 6.3. The confidence statements in these sections range from low to high. Therefore, that ES statement should not exceed "high confidence". (UNITED STATES OF AMERICA)
81	6	3	30	3	30	Please clarify "in early history", e.g. since last glacial... (Ye, Siyuan, Qingdao institute of marine geology)
82	6	3	30	3	30	It is stated that natural rates are slower. Perhaps this is so for orbital and lower frequency changes but is it true for all pre-anthropogenic changes? Some natural climate variability occurs over decades [ie, the inception of millennial-scale DO events, other examples during the Holocene] and these are accompanied by large, rapid changes in terrestrial and marine ecosystem changes. Please reword the text to account for this. (UNITED STATES OF AMERICA)
83	6	3	30	3	30	Is it possible to specify how much slower, in broad terms, this past change has been? (Mach, Katharine, IPCC WGII TSU)
84	6	3	33	0	0	With reference to the term "abundance", abundance of what? Likewise the term "extinctions", of what? If species or populations are meant please stipulate which. (UNITED STATES OF AMERICA)
85	6	3	33	3	34	Query – local extinctions or global extinctions. I can think of lots of examples of local extinctions, but no global ones in the marine realm. Fucus virsoides is at risk in the North Adriatic as nowhere to go. (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
86	6	3	34	3	34	The sentence can be read to suggest that we have presently confirmed marine extinctions from climate change. This is not really supported - any present day extinctions (as opposed to local extirpation) that are clearly attributed to climate change should be highlighted in main text. Statements about the fossil record and present day should be separated. (UNITED STATES OF AMERICA)
87	6	3	36	3	37	Delete "often amplification" [put into a following sentence] and delete "additional" in this very awkward sentence. (UNITED STATES OF AMERICA)
88	6	3	36	3	46	Please provide line of sight for this paragraph. (Mastrandrea, Michael, IPCC WGII TSU)
89	6	3	39	3	39	Is it possible to clarify further what is meant by "key observations"? For example, is "observations indicating key vulnerabilities" or "key vulnerabilities, following from observed changes" more accurate? (Mach, Katharine, IPCC WGII TSU)
90	6	3	41	3	42	Does the described "socio-economic vulnerability" always follow from ecosystem services provided to people and societies by the oceans? If so, it could be helpful to specify this. (Mach, Katharine, IPCC WGII TSU)
91	6	3	46	3	46	This paragraph needs to reference the relevant section in the chapter (square brackets) (AUSTRALIA)
92	6	3	46	3	46	Please add reference to (sub)sections where these statements find their basis. (NETHERLANDS)
93	6	3	48	3	50	Does this finding comment on potential limits to adaptation? It would be useful to be explicit about this if so. (Mastrandrea, Michael, IPCC WGII TSU)
94	6	3	50	3	50	delete "e.g." (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)

#	Ch	From Page	From Line	To Page	To Line	Comment
95	6	4	1	4	1	It could be beneficial to specify the context of vulnerability further--"vulnerability to climate change" at a broad level, it seems. (Mach, Katharine, IPCC WGII TSU)
96	6	4	3	4	4	Temperature is only one of a number of factors that determine geographical distribution: Bottom depth and topography, salinity, predators and prey (Sundby, Svein, Institute of Marine Research)
97	6	4	3	4	4	As above, the confidence assessment can be increased to 'very high'. Note that existing text does not say that temperature is the only factor defining species' distributions, nor that it necessarily has its effects directly. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
98	6	4	4	4	4	Insert "ultimately" "....(medium confidence). Ultimately temperature....." (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
99	6	4	6	4	6	delete "e.g." (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
100	6	4	6	4	6	".... Tropical and other species..." (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
101	6	4	8	4	8	associated microalgae (Pechoux, Martin, Institut des Foraminifères Symbiotiques)
102	6	4	13	4	16	The research evidence and credibility of individual size description had moderate reliability (25-26 page 40, 44-45 page 30) , But conclusion (4 page 51) and ES (13-16 page 4) is a very high credibility. Suggestions to verify the situation, and unified description (Zhu, Xiaojin, National Climate Center)
103	6	4	13	4	18	For the statements on these lines, it would be preferable to specify the relevant general time frames. (Mach, Katharine, IPCC WGII TSU)
104	6	4	14	4	13	It should read "...."average body size"...to be correct (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
105	6	4	20	4	20	The relevance of section 6.5 is not clear, given that it is a section on projections. (Mastrandrea, Michael, IPCC WGII TSU)
106	6	4	22	4	25	This sentence (in bold) doesn't make sense grammatically (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
107	6	4	22	4	30	The statement regarding increasing species diversity at high and mid latitudes... in Chapter 6 ES is repetitive with the statement in Chapter 30 ES that "Marine organisms are moving to higher latitudes." Additionally the confidence statements for cited evidence in Ch 6 lines 22-30 indicating a " 30-70% increase in fisheries yield in high latitudes and a 40-60% decrease in the tropics (medium confidence for general trend and low confidence for magnitude of change)" seem to contradict the "high confidence" bold statements in both Ch 6 and Ch 30 ES statements regarding this matter. (UNITED STATES OF AMERICA)
108	6	4	24	4	24	Is the placement of the word "global" ideal here? That is, is it more nearly the redistribution that is global for overall catch potential? (Mach, Katharine, IPCC WGII TSU)
109	6	4	27	0	0	There are several publications that suggest that fish production in the eastern Bering Sea will drop significantly with warming and the loss of sea ice in the southeast which is important for copepod and krill recruitment (Hunt, George, University of Washington)

#	Ch	From Page	From Line	To Page	To Line	Comment
110	6	4	27	4	30	Does "animal displacement" mean that fish migrate? The directions of change in yield are not consistent with evidence cited in chapter 5 p 27 lines 34-35 or with some of chapter 7 (e.g. page 22 lines 49-52; page 23 lines 7-10) . I think our confidence in the direction of change in yield is low (the empirical evidence is mixed) and there is no credible basis for citing very large (30-70%) changes in yield here, even with low confidence. By 2050 the increase in temperature will be of the order 1 deg C, which corresponds to N-S distances of order 300km. The evidence that this will result in changes in yield of 30-70% is not good enough to be given prominence in this Executive Summary, where it will be widely cited (probably without the present confidence statement). Note that chapter 7 page 3 lines 4-8 ascribes medium evidence and high agreement, although it is not clear what this refers to or is based on. Given that there is low confidence about changes in NPP (Chapter 6 page 49 lines 45-50) and that fisheries production depends on NPP, how can we support statements about major changes in fisheries yields? How could fisheries yield increase by up to 70% irrespective of the (unknown) change in NPP? There is an ambiguous comment at chapter 7 page 22 lines 42-43 that indicates the need for some further inter-chapter coordination. (Brander, Keith, Technical University of Denmark)
111	6	4	27	4	30	The approach taken here for communicating specific quantitative projections and confidence in them is very effective. (Mach, Katharine, IPCC WGII TSU)
112	6	4	28	4	29	This overarching comment relates to the SRES scenario, can a comparison to the RCP scenarios be provided as well? (AUSTRALIA)
113	6	4	29	0	0	Term SRES is used at several locations in the chapter and needs to be defined here. (Ambulkar, Archis, Brinjac Engineering Inc.)
114	6	4	30	4	30	The relevance of section 6.2.5 is not clear here. (Mastrandrea, Michael, IPCC WGII TSU)
115	6	4	32	4	32	The emboldened point here that the oceans provide approximately 50% of global NPP is fairly well known and not, I would argue, a key point from the Chapter (and not made elsewhere in the body of the text). More in keeping with the focus on climate change impacts on the ocean system would be the statement that environmental controls on NPP are projected to be altered. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
116	6	4	33	4	33	For this reference to working group 1, the specific relevant chapter and/or sections should ideally be indicated. (Mach, Katharine, IPCC WGII TSU)
117	6	4	33	4	33	Please specify the line of sight to Working Group I here. (Mastrandrea, Michael, IPCC WGII TSU)
118	6	4	34	4	36	The confidence statements for this ES statement contradict a similar statement in Chapter 30, p4, L25-26. Ch 6 ES states "The direction, magnitude, and regional differences of a change of NPP in the open ocean as well as in coastal waters have limited evidence and low agreement for a global decrease projected by 2100. At high (polar) latitude an increase in NPP is also projected with low confidence." However, Ch 30 ES states "In regions where primary productivity has increased (or is predicted to increase) such as....., energy transfer to higher trophic levels is likely to increase along with microbial activity. Increased primary productivity is likely to lead to an increased transfer of organic carbon to deep sea habitats..." The confidence and likelihood statements in these two ES statements seem to contradict one another. It is suggested that the ES statement be limited to only one of the chapters and the text modified to clarify the confusing confidence and likelihood statement. (UNITED STATES OF AMERICA)
119	6	4	38	4	38	In describing the types of microbes within parentheses here, would it be clearest to introduce the word phytoplankton here? (Mach, Katharine, IPCC WGII TSU)
120	6	4	38	4	47	Part of the ES bold expression is middle credibility, but the specific describe is low credibility. Please verify and unified. (Zhu, Xiaojin, National Climate Center)

#	Ch	From Page	From Line	To Page	To Line	Comment
121	6	4	38	4	47	There is inconsistency between the confidence statements for the primary (bold) ES statement regarding microbes roles in marine ecosystems which is assigned "medium confidence" and all of the supporting evidence for the ES statement which ranges from "low confidence" to "limited evidence, low agreement". Suggest changing bold statement assignment of medium confidence to low confidence, or clarifying the confidence assignments for the supporting statements. (UNITED STATES OF AMERICA)
122	6	4	46	4	46	It should read "development and proliferation of harmful algal blooms (low confidence) or pathogens such as the agent that causes cholera"...to be correct (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
123	6	4	47	4	47	The relevance of section 6.5 is not clear here. (Mastrandrea, Michael, IPCC WGII TSU)
124	6	4	49	4	51	"Laboratory, mesocosm and field data show that ocean acidification has ramifications for processes ranging from physiology and behavior to population dynamics. . . A wide range of sensitivities to projected acidification exists within and across organism phyla (high confidence). This is a gross overstatement. Acidification effects have been mostly demonstrated in laboratory experiments using much stronger acids than carbonic acid. The physical chemistry of the exchange of carbon dioxide between the atmosphere and the ocean is well known, with carbon dioxide transferring in ocean waters from dissolved gas to carbonate, then bicarbonate, then to calcium carbonate and other carbonate salts. The primary and probably exclusive acidification will take place only in the upper, photic zone of the oceans, that affected by winds, tides, and sunlight. Past physical chemistry analyses suggest that this section of the ocean comes into equilibrium with the atmosphere within about 10 years, and the carbon dioxide is gradually moved downward as well. This is classic and standard physical chemistry, as explained in the classic book, which should be referred to here: Hutchinson, G.E., A Treatise on Limnology: Vol I, Geography, Physics and Chemistry; Vol II, Introduction to Lake Biology and the Limnoplankton, 1967, 1115pp; Vol III, Limnological Botany, 1975, 660pp,. 1967 - 1975: John Wiley & Sons, N.Y. . (UNITED STATES OF AMERICA)
125	6	4	49	5	13	We believe it would be appropriate also to describe the effects on fish in the ex.summary see page 24 line 3-8. (NORWAY)
126	6	4	53	4	54	"Most plants, including algae, respond positively to elevated CO2 levels by increasing photosynthesis and growth (high confidence)." Basic biology: Algae are not plants. There are five kingdoms of life, and algae are in a separate group. A professional report purposing to be scientific should at least be correct about basic biology. See 1. Margulis, L., K. V. Schwartz, M. Dolan, K. Delisle, C. Lyons Diversity of Life: The Illustrated Guide to the Five Kingdoms. 1999, Sudbury, MA Jones & Bartlett Publishers. The statement is incorrect. Yes, plants in a greenhouse under constant environmental conditions respond to increases in carbon dioxide, following Michaelis-Menten kinetics, which is a nonlinear saturation curve. There are hundreds of scientific papers that demonstrate this response. However, results have been published on the use of the JABOWA computer model of forest growth combining temperature and precipitation changes from one of the GCMs and know, parameterized responses of tree species to carbon dioxide increase. For reasons explained in that paper, there is no statistical difference in the biomass increase in a forest under those conditions. One reference is: Botkin, Daniel B. and Robert A. Nisbet, 1990, "The Response of Forests to Global Warming and Co2 Fertilization" Report to EPA, January 1990. Copies of the report can be obtained from the authors. (UNITED STATES OF AMERICA)
127	6	4	53	4	54	The statement that "most plants respond positively" is a bit misleading - other factors besides CO2 are most often limiting. (UNITED STATES OF AMERICA)

#	Ch	From Page	From Line	To Page	To Line	Comment
128	6	5	1	0	0	it would be good to mention here that research suggests that ocean acidification has generally negative impacts on marine calcifiers and may result in changes to biodiversity, trophic interactions, and other ecosystem processes (Royal Society, 2005; Kleypas et al., 2006), although there is an emerging variation in response to ocean acidification. Most calcifying organisms investigated to date demonstrate reduced calcification in response to increased pCO ₂ and decreased [CO ₃ ²⁻], CaCO ₃ saturation state, and pH (e.g. Gattuso et al., 1998; Langdon et al. 2003; Riebesell et al., 2000). Royal Society. The Royal Society. London; 2005. Ocean acidification due to increasing atmospheric carbon dioxide. Policy Document 12/05; p. 60. Kleypas J. A., Langdon C. Coral reefs and changing seawater chemistry. In: Phinney J. T., Hoegh-Guldberg O., Kleypas J., Skirving W., Strong A., editors. Coral Reefs and Climate Change: Science and Management. Washington, DC: American Geophysical Union; 2006. p. 73-110. AGU Monograph Series Coastal Estuarine Studies 61. Riebesell U., Zondervan I., Rost B., Tortell P. D., Zeebe R. E., Morel F. M. M. Reduced calcification of marine plankton in response to increased atmospheric CO ₂ . Nature 2000; 407:364-367. Langdon C., Broecker W. S., Hammond D. E., Glenn E., Fitzsimmons K., Nelson S. G., Pend T-H., et al. Effect of elevated CO ₂ on the community metabolism of an experimental coral reef. Global Biogeochemical Cycles 2003; 17:1011. doi:10.1029/2002GB00. Gattuso J-P., Frankignoulle M., Bourge I., Romaine S., Buddemeier R. W. Effect of calcium carbonate saturation of seawater on coral calcification. Global and Planetary Change 1998; 18:37-46. (McLeod, Elizabeth, The Nature Conservancy)
129	6	5	2	5	2	It would be clearest to specify which type of change meant here--"projected ocean acidification" might be preferable. (Mach, Katharine, IPCC WGII TSU)
130	6	5	3	0	0	A link could be made to Box CC-OA (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
131	6	5	3	0	0	remain POORLY explored (because there is limited information on phytoplankton) (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
132	6	5	3	5	3	In this sentence, and throughout the rest of the chapter, confidence statements sometimes appear ambiguous. In this sentence it is unclear that the confidence relates to adaptational capacity, rather than the exploration of it. (AUSTRALIA)
133	6	5	3	5	3	The statement that "Limits to adaptational capacity..." - as worded - does not need a confidence level assigned to it. (UNITED STATES OF AMERICA)
134	6	5	3	5	3	Is usage of "low confidence" here as clear as it could be? It seems the chapter team may have high confidence that limits to adaptive capacity remain unexplored and, more nearly, low confidence in what the limits might be. (Mach, Katharine, IPCC WGII TSU)
135	6	5	5	0	0	I do not think that 30% increase in ocean acidity since preindustrial time is "limited" (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
136	6	5	5	0	6	"Field observations attributed to ocean acidification are few due to limited changes in water chemistry between pre-industrial times and today." - Not sure I agree with this - the field observations are not few because there are a lack of such changes - they are few because it is a relatively new area of research and the capacity to assess it is limited - also this ignores the major fluctuations in pH/aragonite saturation state that can occur at the local scale due to local processes (oceanography, benthic community composition) - these changes can be greater than those projected by the end of the end of the century for the global oceans (McLeod, Elizabeth, The Nature Conservancy)
137	6	5	5	5	5	It seems that working group 1 findings indicate that, overall, substantial ocean acidification has been observed to date. It might be helpful to clarify further the nature of the "limited changes" referred to here--changes are relatively small in specific locales as compared to natural variability, the effects of changes in ocean acidification are small as compared to the impacts of other stressors, etc.? (Mach, Katharine, IPCC WGII TSU)

#	Ch	From Page	From Line	To Page	To Line	Comment
138	6	5	5	5	6	The statement that "Field observations attributed to anthropogenic ocean acidification are few due to limited changes in water chemistry between pre-industrial times and today" should be changed to "Field observations attributed to anthropogenic ocean acidification are few due to confounding factors from other local and regional impacts". Otherwise, this statement contradicts the statement in Ch 30, p3, L 31-35 stating that the increased uptake of CO2 has decreased pH and fundamentally changed ocean chemistry, and that the rate of change in water chemistry is unprecedented in millions of years. (UNITED STATES OF AMERICA)
139	6	5	9	5	9	Note that Pacific oysters are not native to US west coast - not adapted to natural west coast CO2 levels (UNITED STATES OF AMERICA)
140	6	5	10	5	11	The text "Ecosystems at risk of ocean acidification are warm and cold water coral reefs" should be changed to "Ecosystems at risk of ocean acidification include warm and cold water coral reefs" because reefs are not the only ecosystems at risk. (UNITED STATES OF AMERICA)
141	6	5	11	0	0	There is no "cold water coral reefs". They should be called "deep-sea or cold-water coral communities" because a reef is a navigational hazard. (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
142	6	5	12	0	0	Compensation has recently been disputed and it was suggested that there is no effect of ocean acidification until a certain pCO2 threshold (Maier C., Schubert A., Berzunza Sánchez M. M., Weinbauer M. G., Watremez P. & Gattuso J.-P., 2013. End of the century pCO2 levels do not impact net calcification in Mediterranean cold-water corals. PLoS ONE 8:e62655.) (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
143	6	5	15	5	19	Food availability is also an environmental driver that should be discussed in the text. (UNITED STATES OF AMERICA)
144	6	5	15	5	19	This paragraph seemingly overlaps with the 4th paragraph of the executive summary, and the intended contrasts could be further highlighted for the reader. (Mach, Katharine, IPCC WGII TSU)
145	6	5	16	0	0	not sure you can say "physiological knowledge projects" - could you instead say "current research suggests..." (McLeod, Elizabeth, The Nature Conservancy)
146	6	5	16	5	16	Delete "For example, physiological knowledge projects that" This edit may make this statement clearer. (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
147	6	5	17	5	17	"...hypoxia act to narrow thermal..." (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
148	6	5	19	0	0	Replace "warm water corals" by "reef-building corals" (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
149	6	5	21	5	23	Since hypoxia and anoxia are referred to a number of times in the Executive Summary it may be useful to include definitions for non-specialists (e.g. Hypoxia approximately < 60 umol/L) (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
150	6	5	21	5	23	The effects on habitat are presented with medium confidence on page 34--please reconcile with the presentation of high confidence here. (Mastrandrea, Michael, IPCC WGII TSU)
151	6	5	21	5	25	The general time frame for these statements should be clarified. Additionally, how important has climate change been for these observed changes, as compared to eutrophication, etc? Within the bold sentence for example, it could be helpful to clarify that the ongoing expansion is at least partially due to climate change. (Mach, Katharine, IPCC WGII TSU)

#	Ch	From Page	From Line	To Page	To Line	Comment
152	6	5	21	5	28	"The ongoing expansion of hypoxic regions termed Oxygen Minimum Zones (OMZs) constrains the habits of O2-dependent animals, plants, and microbes, while it benefits anaerobic microbial life (high confidence). Warming-induced stratification, reduced intensity of ocean circulation and the decomposition of organic matter by heterotrophic organisms create an expansion of these specialize, microbially dominated ecosystems. The assumption here is that global warming will decrease ocean circulation. But there is evidence that a global warming transition climate could increase some ocean circulation, so this statement cannot be left as the generalization, which implies a certainty. Second, again, since "algae" is not used directly, the text appears ignorance of basic biological taxonomy, as algae are not in the Plant division. (UNITED STATES OF AMERICA)
153	6	5	30	5	32	Content and above paragraph (21-18) belong to the same theme, the proposal to merge. (Zhu, Xiaojin, National Climate Center)
154	6	5	30	5	32	This point is quite vague and "medium confidence" - could this be amalgamated into another statement or removed from the Executive Summary? Moreover the statement of "[...] but in addition to hypoxia effects consequences for higher trophic levels in those areas remain unknown" seems too uncertain for the Executive Summary, or at very least should be added to the paragraph about OMZs above (Page 5; Line 21).. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
155	6	5	30	5	32	delete " but in addition to hypoxia effects" Insert at the end of line 32 "other than effects of hypoxia" (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
156	6	5	30	5	32	There are no supporting statements for this ES statement despite the fact that 4 chapter sections are referenced. Supporting statements should be included here to be consistent with the other ES statements in this chapter. (UNITED STATES OF AMERICA)
157	6	5	30	5	32	The timeframe of this statement should be clarified. In particular, it seems the author team is saying that intensified upwelling has already occurred--it would be clearest if the chapter team indicated for how long such intensification has been observed and whether or not climate change has played a role in the patterns observed. (Mach, Katharine, IPCC WGII TSU)
158	6	5	30	5	32	Section 6.3.5 also appears to provide relevant information. (Mastrandrea, Michael, IPCC WGII TSU)
159	6	5	34	5	34	This paragraph on geoengineering could be improved by providing an example of the environmental impacts and what is meant by 'purposeful alteration' of the ocean. In addition, it is not clear what is meant by 'solar radiation management leaving ocean acidification unabated' if only reading the Executive Summary. (AUSTRALIA)
160	6	5	34	5	37	Please consider the large uncertainties attached to geoengineering and reformulate, e.g.: "...are expected to have very large associated environmental footprints..." 2) Solar radiation management is expected to have other side effects. This should not be neglected here. Please add: "unabated (but are expected to have other negative side effects as e.g. change in precipitation). (GERMANY)
161	6	5	35	5	35	CO2 injection is general considered as a storage option. Comparable to geological CCS. The CO2 (before injection) needs to be very pure. So this falls more into CCS storage options then geoengineering (definition: "the deliberate large-scale manipulation of an environmental process that affects the earth's climate, in an attempt to counteract the effects of global warming.". The ocean acts merely as a (temporal) storage place. (NETHERLANDS)
162	6	5	37	0	38	it is true that methods focusing on solar radiation leave ocean acidification unabated but might be useful to mention that this not because of limitations of the methods themselves, rather such methods do not address the driver of acidification which is increasing atmospheric CO2 - i think this is what is intended but could be stated more explicitly/clearly (McLeod, Elizabeth, The Nature Conservancy)

#	Ch	From Page	From Line	To Page	To Line	Comment
163	6	5	37	0	38	Again, we suggest different wording: "Climate geoengineering techniques based on solar radiation management will not abate ocean acidification, and, in some cases, could increase it (Williamson and Turley, 2012). (Mooney, Pat Roy, Action Group on Erosion, Technology and Concentration (ETC Group))
164	6	5	37	5	37	The authors should delete the word "Alternative." (UNITED STATES OF AMERICA)
165	6	5	37	5	38	See the comment to (Chapter 5, Page 50, Lines 26-28) (Ryaboshapko, Alexey, Institute of Global Climate and Ecology)
166	6	5	37	5	38	This sentence describes another geoengineering method not an "alternative" method to geoengineering. Furthermore we believe the text should mention the issue of a sudden cessation of SRM. Therefore we propose the following changes: "Other geoengineering me (NORWAY)
167	6	5	39	5	39	We believe adaptation benefits and threats and low-regret options also should be described in the Ex. summary e.g. see page 60 line 31-45. (NORWAY)
168	6	5	43	5	44	If the atmosphere is included in the biosphere 95% is not correct (Sundby, Svein, Institute of Marine Research)
169	6	5	43	5	44	I like the strong opening, but is it fair to say that 95% of the habitable environment by volume is the ocean? What about the atmosphere, or is the atmosphere not rigorously part of the "planet"? (Mach, Katharine, IPCC WGII TSU)
170	6	5	44	0	0	marine habitats exhibit natural variability on BOTH temporal and spatial scales (Mcleod, Elizabeth, The Nature Conservancy)
171	6	5	45	5	45	"Synoptic" could be considered jargon that would be preferable to avoid in an opening statement. (Mach, Katharine, IPCC WGII TSU)
172	6	5	46	5	47	The available information indicates that oceanic ecosystems are particularly sensitive to stresses mediated by climate change. As stated, this is false and meaningless. "particularly sensitive" provides no information to present in a supposedly scientific based document. Many oceanic ecosystems are very robust against climate change. Some life forms, like the chambered nautilus, have existed in much their present form for 500 million years, so their ecosystems have undergone great changes. Therefore, the quoted sentence should be deleted or completely rephrased to "Of the known and studied marine ecosystems, some are . . . " (UNITED STATES OF AMERICA)
173	6	5	47	5	50	"... climate change; partly because of direct effects on organisms and their interactions; and partly because physical and chemical forcing controls ocean temperatures..... and light regime. In turn these factors determine growth of phytoplankton..." delete "and hence" (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
174	6	5	49	5	49	add: "turbulent mixing" after upper ocean stratification (Sundby, Svein, Institute of Marine Research)
175	6	5	51	5	51	Functioning is better than function. (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
176	6	5	51	5	52	Please consider to reference Ch3 of the WGI AR5 early on to link to the assessment of ocean physical science basis observations. (Plattner, Gian-Kasper, IPCC WGI TSU)
177	6	5	54	5	54	One could argue that oceans impacts were assessed in the 1st assessment report and 2nd assessment report, and wording here could be clarified. For example, please see the summary within figure 1-2. (Mach, Katharine, IPCC WGII TSU)
178	6	6	0	0	0	Figure 6-1. Recent studies (Hirawake et al., 2011, Polar Biology, 34, 291-302; Hirawake et al., 2012, ICES Journal of Marine Science, 69, 1194-1204) have pointed that the traditional algorism to estimate the phytoplankton Chl. a from ocean color sensor, SeaWiFs and MODIS is quite overestimate because the algorism cannot separate the influence of colored dissolved organic matter and non-algal particles. Hirawake et al., 2011 and 2012 also suggested new model, a phytoplankton absorption-based primary productivity model (ABPM) to accurately estimate the phytoplankton Chl a. It is nice if the report suggests for utilization of plural algorisms and recommends the innovation of new algorisms to estimate accurately global scale phytoplankton Chl a. (Harada, Naomi, Japan Agency for Marine-Earth Science and Technology)

#	Ch	From Page	From Line	To Page	To Line	Comment
179	6	6	3	6	3	With regard to the statement "For some of those, confidence has changed..." Can you state the most significant changes here? (UNITED STATES OF AMERICA)
180	6	6	5	6	12	The authors should also consider Marine Ecosystems of the World (Spalding et al.) for coastal systems (UNITED STATES OF AMERICA)
181	6	6	7	6	7	Section 6.1: As has been acknowledged at several places in the document the present collation had sparse data from sensitive ecosystems of the world. The IPCC has to place a specific recommendation for the regional governments/countries to develop regional programmes (INDIA)
182	6	6	8	6	8	Delete "scale which " and insert "that" to give "...ecosystem that is required..." (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
183	6	6	9	6	10	How much are these biomes used within this chapter? One possibility would be to simply cross-reference the similar chapter 30 figure here. (Mach, Katharine, IPCC WGII TSU)
184	6	6	14	6	14	Body size decrease is not mentioned in paragraph and should be considered for inclusion. (UNITED STATES OF AMERICA)
185	6	6	15	6	15	Given that scenarios other than the RCP scenarios are used as part of the assessment in the chapter, it could be helpful to clarify this wording slightly. (Mach, Katharine, IPCC WGII TSU)
186	6	6	16	6	16	We often misuse the word parameter. "Variable" is the correct here, or if one would use a more general term: "factor". (Sundby, Svein, Institute of Marine Research)
187	6	6	16	6	19	The right unit for atmospheric CO2 is a concentration unit (ppm or ppmv) (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
188	6	6	19	6	19	2100.-On -> 2100. On (Eliseev, Alexey V., A.M.Obukhov Institute of Atmospheric Physics, Russian Academy of Sciences)
189	6	6	22	6	22	An increase in the diversity of animals and plants listed in the bold faced statement does not seem to match text below (UNITED STATES OF AMERICA)
190	6	6	23	6	29	For the non-specialist Fig 6-1 is mis-leading, since it implies high productivity in the Arctic and in some coastal areas, which are not associated with eastern boundary current regions. I suggest adding the following sentence to the Legend: "In seasonally ice-covered regions (e.g. north of Russia) annual average chlorophyll a concentrations are for the ice-free season and do not represent annual averages. As well, in some coastal areas signals received by satellite lead to overestimation of chlorophyll concentration due to interference by coloured dissolved organic material (CDOM) and/or re-suspended sedimentary material." (Head, Erica, Fisheries and Oceans Canada)
191	6	6	30	0	0	"The rate of ocean acidification in surface waters presently..." (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
192	6	6	31	0	0	It is absolutely essential to mention the pH scale every time an absolute pH value is given. This can be done by adding a subscript to "pH" (NBS, T, SWS or F). (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
193	6	6	32	0	0	Section 6.1.1. For the working group 1 cross-references provided within this section, it would be preferable to specify the specific relevant chapter sections where possible and appropriate. (Mach, Katharine, IPCC WGII TSU)
194	6	6	32	6	32	"variable" (Sundby, Svein, Institute of Marine Research)
195	6	6	32	6	34	The following review paper maybe useful for Section 6.1.1: Sen Gupta A & B McNeil (2012) Variability and change in the ocean. In: The Future of the World's Climate, A Henderson-Sellers & K McGuffie (eds), Elsevier, Amsterdam, pp 141-165. (Lough, Janice, Australian Institute of Marine Science)
196	6	6	32	6	34	This important introductory statement to Sect 6.1.1 could be more specific and correctly cited. Particularly, there is only limited discussion of the attribution of ocean carbon changes to rising CO2 in WG1 Ch. 10 - suggest to also include reference to WG1 Section 3.8 here (and also specify Table 10.1 from Ch. 10). (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)

#	Ch	From Page	From Line	To Page	To Line	Comment
197	6	6	32	8	51	There is need here for some more integration with Ch 30. Specifically, the introduction which references D&A of ocean variables should also refer to Sect 30.5.8. Also Section 6.1.1 is very similar to Section 30.3.1, which is something that may require more work to improve consistency of messages between Chapters. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
198	6	6	33	6	33	CO2 levels likely have a limited effect on ocean NPP, it is seldom a limiting species (UNITED STATES OF AMERICA)
199	6	6	33	6	34	Insert "in" and delete "on e.g." to give "...variability in temperature..." (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
200	6	6	33	6	34	Why mention salinity when it is not covered in the next section. List the factors in full covered in the next section; warming, acidification, hypoxia, other? (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
201	6	6	33	6	34	One sentence paragraph? Also, this sentence doesn't mention hypoxia which is a section. (UNITED STATES OF AMERICA)
202	6	6	39	6	53	This section mentions ENSO but not any of the other factors such as PDO, NPGO, etc. These are mentioned later in chapter but should be here. Also, consider putting concept that warming affects T and S up front. (UNITED STATES OF AMERICA)
203	6	6	42	0	0	ENSO term is not defined or elaborated in this chapter prior to being used in this sentence. Actually it is defined at page 11, line 28 instead. So, please revise accordingly. (Ambulkar, Archis, Brinjac Engineering Inc.)
204	6	6	43	6	44	Also at high latitudes the amplitude of interannual variations are much larger than the amplitude of multidecadal variations - but ecological effects are much larger from the multidecadal variability - and the existence of multidecadal variability is probably more prevailing at high latitudes. (Sundby, Svein, Institute of Marine Research)
205	6	6	44	6	44	There should be mention of seasonal (and higher frequency) variability, e.g. due to storms (UNITED STATES OF AMERICA)
206	6	6	48	6	51	Freshening of surface ocean has also been observed in parts of the tropical oceans, see Durack et al (2012) Ocean salinities reveal strong global water cycle intensification during 1950 to 2000. Science 336: 455-458. (Lough, Janice, Australian Institute of Marine Science)
207	6	7	2	7	2	Please add the word "annual" as suggested. "Figure 6-2: Sea surface temperature variability in the last century (1911 to 2011). The top left map shows the annual sea" (Head, Erica, Fisheries and Oceans Canada)
208	6	7	4	7	4	Please add the word "annual" as suggested. "difference between the maximum and minimum annual values for each grid etc." (Head, Erica, Fisheries and Oceans Canada)
209	6	7	4	7	7	This sentence is incomprehensible. Please reword to clarify meaning. (UNITED STATES OF AMERICA)
210	6	7	15	7	15	CO2 should be stated as a mole fraction (ppm) not as a partial pressure (i.e., in uatm) (UNITED STATES OF AMERICA)
211	6	7	17	7	17	Sentence ending in "...and following several RCPs" is not clear. Please reword the sentence. (UNITED STATES OF AMERICA)
212	6	7	18	7	33	A minor point, but the values provided on line 19 appear to be rounded values as compared to those on line 32-33, which could potentially be confusing for the reader and might be best to avoid. (Mach, Katharine, IPCC WGII TSU)
213	6	7	19	0	0	"-" needs to be removed between sentences i.e. "2100." and "On average..." (Ambulkar, Archis, Brinjac Engineering Inc.)
214	6	7	19	7	19	delete hyphen (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
215	6	7	20	7	20	Replace "drawdown" with "uptake." (UNITED STATES OF AMERICA)
216	6	7	21	7	21	Delete "an increase in acidity measured as a" insert "due to" to give "... ocean acidification (OA), due to decline..." (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
217	6	7	23	7	23	Solubility is a physical constant and not related to concentration as implied here. Please reword text to clarify. (UNITED STATES OF AMERICA)
218	6	7	25	7	27	This sentence should be supported with references for the reported natural variability. (UNITED STATES OF AMERICA)

#	Ch	From Page	From Line	To Page	To Line	Comment
219	6	7	27	7	29	Section 6.1.1.2: The IPCC has to make a specific recommendation to generate long-term records in the oceans around keeping with the particular sensitivity of the system in the neighbourhood. (INDIA)
220	6	7	32	7	32	The statement "...and is expected to drop until 2100" makes it sound like it will stop in 2100. Please restructure sentence to read "and is expected to drop by -0.13...by the year 2100". (UNITED STATES OF AMERICA)
221	6	7	32	7	32	There are no "pH units". Remove the words "pH units". (UNITED STATES OF AMERICA)
222	6	7	35	7	36	Please explain why / how salinity reduction exacerbates OA. (UNITED STATES OF AMERICA)
223	6	7	37	7	39	...will take tens of thousand years for neutralisation and hundreds of thousand years... (neutrilsation require several turnover of a 1500 cycle, and weathering is on 200-500 000 years time scale) (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
224	6	7	44	8	28	Units for oxygen. Please provide mg/L conversion in parentheses. That is EPA standard, so will widen the audience. (UNITED STATES OF AMERICA)
225	6	7	50	7	50	What does synoptic mean? Not a common usage? (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
226	6	8	2	8	2	Give % surface area? (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
227	6	8	2	8	2	"0.5 ml L-1" should be converted to mg/L. (UNITED STATES OF AMERICA)
228	6	8	2	8	2	Area or volume incorrect as these numbers would make the average depth of the hypoxic layer 3.4 km! (UNITED STATES OF AMERICA)
229	6	8	3	8	3	Section 6.1.1.3: replace word 'basis' by 'basin' (INDIA)
230	6	8	8	8	8	Replace "basis" with "basins" (Head, Erica, Fisheries and Oceans Canada)
231	6	8	8	8	8	Basis' should read 'basins' (AUSTRALIA)
232	6	8	9	8	9	The statement "caused by respiration coinciding with CO2 accumulation" is unclear. How are these two different? (UNITED STATES OF AMERICA)
233	6	8	9	8	10	Is this described decrease in oxygen an average value for oxygen minimum zones or mid-waters? (Mach, Katharine, IPCC WGII TSU)
234	6	8	12	8	13	Worth mentioning that the long term decreases in North Pacific O2 come from 2 time series datasets (Oyashio: Ono et al., 2001 ; Ocean Station Papa: Whitney et al., 2007). These data are what Keeling et al. (2010) plot in their review paper. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
235	6	8	12	8	15	There is some need to differentiate here between the coastal and open ocean. For example, one sentence about open ocean O2 decreases in the North Pacific (line 12) followed by a statement about hypoxic coastal regions is potentially confusing to non-specialists. One option could be to include reference to Gilbert et al. (2010), Biogeosciences, as a segue, who identify greater historical O2 declines in the coastal ocean than the open ocean. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
236	6	8	13	8	14	The sentence beginning 'The number of...' is particularly unclear and should be re-phrased. It is unclear that the phrase 'excluding metazoans' is being used to describe the hypoxic coastal regions. The structure of the sentence could be changed to improve this, and the term metazoans could perhaps be defined, or replaced with simpler wording. (AUSTRALIA)
237	6	8	13	8	14	The "excluding metazoans" within this sentence is confusing. Please correct or clarify this sentence. (UNITED STATES OF AMERICA)
238	6	8	16	8	16	Is it worth saying this has always been the case in the Black Sea? The Aral Sea is not really an ocean system. (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)

#	Ch	From Page	From Line	To Page	To Line	Comment
239	6	8	17	8	19	With future warming, the spread of hypoxic zones will very likely accelerate, especially in temperate to subpolar regions where increases in ocean stratification due to warming or freshening of the surface layer can reduce the depth of winter mixing and create dense waters in association with ice formation." (Head, Erica, Fisheries and Oceans Canada)
240	6	8	17	8	19	I suggest deleting the phrase "create dense waters in association with ice formation": it is incorrect. Warming and freshening of the surface layer will indeed likely reduce the depth of winter mixing, but will not "create dense waters in association with ice formation". If anything, warming will lead to less ice formation, and thus less brine rejection and less formation of dense sub-surface waters. (Head, Erica, Fisheries and Oceans Canada)
241	6	8	17	8	20	Statement on hypoxic waters is not supported by WGI: "There is however no consensus on the future development of the volume of hypoxic and suboxic waters because of large uncertainties in potential biogeochemical effects and in the evolution of tropical ocean dynamics" (WGI AR5 Ch06 ES). Please revise accordingly using the Final Draft of WGI AR5. (Plattner, Gian-Kasper, IPCC WGI TSU)
242	6	8	23	8	23	The phrase "climate-related intensification of the global water cycle" is vague. Please define this phrase. (UNITED STATES OF AMERICA)
243	6	8	24	8	24	A sentence that says only "Figures vary for regions and areas" is not very informative. Please state the types of data that vary within these figures. (UNITED STATES OF AMERICA)
244	6	8	26	8	28	The likelihood of methane hydrate destabilization should be discussed somewhere in chapter 6. (UNITED STATES OF AMERICA)
245	6	8	27	8	27	replace "exacerbating" with exacerbate (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
246	6	8	31	8	41	Please consider to also cross-reference WGI AR5 in this section. (Plattner, Gian-Kasper, IPCC WGI TSU)
247	6	8	33	8	33	Delete "Most experiments" to give "Modeling indicates that..." (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
248	6	8	33	8	34	Important to include reference recent work which looks at mixed layer changes in the CMIP5 models here. Specifically Saltee et al. (2013), JGR:Oceans [DOI: 10.1002/jgrc.20157]. This paper looks into historical and future changes in mixed layer depths in the Southern Ocean and finds future shallowing (particularly in the Pacific basin). (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
249	6	8	33	8	34	Will not stormier seas deepen the mixing layer? (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
250	6	8	38	8	38	A reduction in nutrient supply seems to contradict the increases in global productivity in figure 6-5. Please clarify (see page 11 line 40). (UNITED STATES OF AMERICA)
251	6	8	46	8	46	Delete "driver e.g." to give "... regimes of rising..." (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
252	6	8	46	8	47	The statement that is is "virtually certain" that marine ecosystems under climate change are exposed to a changing regime of drivers is central to the whole chapter, and should be included in the Executive Summary. This summary provides a high confidence physical basis for the discussion of ecosystem sensitivity to climate discussed in later sections, and it would be useful to explicitly highlight this to readers of the ES. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
253	6	8	46	8	47	The chapter team could consider placing "virtually certain" within parentheses at the end of the sentence. (Mach, Katharine, IPCC WGII TSU)
254	6	8	46	8	48	It is virtually certain that with climate change, marine ecosystems are exposed to changing regimes of drivers, e.g. rising temperature, ocean acidification and the expansion of hypoxic zones. This is not virtually certain. (UNITED STATES OF AMERICA)
255	6	8	47	8	47	change to say "...surface layers will very likely enhance and prolong stratification, thereby limiting the nutrients available...." (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)

#	Ch	From Page	From Line	To Page	To Line	Comment
256	6	8	47	8	51	Am I being stupid: surely enhanced stratification will deepen the mixed layer? This may need to be made clearer and better argued. (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
257	6	8	50	8	51	No, light availability will be the same at given depth. This sentence is badly formulated, but I don't know how to write it better (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
258	6	8	50	8	51	Light availability changes are mentioned in the conclusion, but there is no reference to light availability, or references supporting it, throughout the rest of Section 6.1.1 (AUSTRALIA)
259	6	8	50	8	51	"Light availability to phytoplankton will likely increase due to shoaling of the surface mixed layer". This statement appears in "6.1.1.5 Conclusion", but the mechanism underlying this statement is unclear as it has not been explained in the previous sections of 6.1.1. Unless some very specific assumptions about the mixed layer versus the depth of the euphotic zone are made, this conclusion appears wrong. In particular if increased stratification leads to reduced upward nutrient transport and reduced primary production, the euphotic zone will become deeper due to less shading from phytoplankton and more light will be absorbed by the water as the light penetrates the water column, i.e. less light will be available for phytoplankton. (Aksnes, Dag Lorents, University of Bergen)
260	6	8	51	8	51	"increase due to shoaling of the surface mixed later becoming shallower." (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
261	6	9	0	0	0	Figure 6-11: Reference to Figure 6-11 is out of order in text. This should be Figure 6-3. Figures throughout the chapter will need to be renumbered. (UNITED STATES OF AMERICA)
262	6	9	0	0	0	Figure 6-3: There is no reference to figure 6-3 in the text. (UNITED STATES OF AMERICA)
263	6	9	3	9	11	General statements about paleo-records should emphasize large biogeographic shifts in species and ecosystems distribution that accompany climate changes, most notable orbital-scale oscillations. These are more prominent than extinctions or evolutionary appearances. Not only "expansion" of ranges, but contraction. (UNITED STATES OF AMERICA)
264	6	9	6	9	6	Change to "... forcings to which organisms are responding." (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
265	6	9	8	9	8	I think "Figure 6-11" should be "Figure 6-3". (Head, Erica, Fisheries and Oceans Canada)
266	6	9	10	9	11	Delete " of the last centuries" to give "...data sets from organisms..." (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
267	6	9	11	9	11	Insert "for example slow-growing bivalve molluscs or corals". (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
268	6	9	13	9	21	The sediment records of marine species distribution do allow confident inferences about major drivers at large spatial scales and large climate oscillations - SST, BWT, and in coastal zones, salinity etc. Please reword this sentence (UNITED STATES OF AMERICA)
269	6	9	15	9	17	In the sentence beginning 'Importantly though,' the use of the present tense to describe activities in the geological past is confusing. Suggest re-phrasing. (AUSTRALIA)
270	6	9	15	9	17	This sentence (starting "Importantly though...") doesn't make sense grammatically (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
271	6	9	17	0	19	last part does not follow bad sentence (Hunt, George, University of Washington)
272	6	9	18	9	18	Please provide a specific reference to WGI, e.g. WGI Ch5. (Plattner, Gian-Kasper, IPCC WGI TSU)
273	6	9	19	9	19	Insert " from" to give "... record and from global circulation..." (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
274	6	9	20	9	20	replace "inform" with "forecast" (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
275	6	9	23	9	33	Not sure how to interpret this figure (Fig 6-3) as multiple localities. Are we inferring cause and effect?? (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
276	6	9	25	9	26	Fig 6-3. Legend, add: Note different time scale by a factor of 1500 (Pecheux, Martin, Institut des Foraminifères Symbiotiques)

#	Ch	From Page	From Line	To Page	To Line	Comment
277	6	9	27	9	27	...model output, only indicative (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
278	6	9	30	9	30	Please note that a correction to the De'ath et al (2009) paper on GBR calcification will shortly appear in Science. This reduces the observed decline from 14.1 to 11.2% but does not alter the significance of the overall findings. (Lough, Janice, Australian Institute of Marine Science)
279	6	9	35	9	35	Express per decade or century as the resolution of these observations are not on annual scales (UNITED STATES OF AMERICA)
280	6	9	35	9	38	This section could also mention Jaccard and Galbraith (2011), who show climate driven changes in oceanic oxygen during the last glacial termination, based on a compilation of marine sediment proxy data. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
281	6	9	39	0	0	Please give actual LGM mean annual temperature and estimates of LGM cooling at high and low latitudes [much greater high lat cooling] (UNITED STATES OF AMERICA)
282	6	9	39	9	40	delete "'s ocean" to give " ... rich than today's ocean." (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
283	6	9	40	9	40	The chapter team could consider placing "high confidence" within parentheses at the end of the sentence. (Mach, Katharine, IPCC WGII TSU)
284	6	9	40	9	42	Please stipulate planktic foraminifera. Reword the sentence as the B/A event is actually a part of the entire deglacial transition. The way it is worded sounds like the deglacial is separate from the B/A. As in prior comment, equatorward expansion occurs during interglacial to glacial transitions (UNITED STATES OF AMERICA)
285	6	9	43	6	44	Calcification leads to increase in CO2 according to chemical reaction in seawater. If this description is right, more information is necessary. (MURATA, AKIHIKO, Japan Agency for Marine-Earth Science and Technology)
286	6	9	43	9	47	Please reword paragraph. As it stands, it sounds like the Arabian Sea experienced true species extinctions while actually it was just range shifts and local populations leading to lower glacial diversity. It would be useful to point out that dozens of 100-kyr and 41-kyr orbital cycles causing major ocean changes do not lead to species extinctions, only range expansion-contraction. (UNITED STATES OF AMERICA)
287	6	9	44	9	44	...in planktonic foraminifers (references required) and coccolithophorids (Beaufort et al., 2011)(medium evidence, medium agreement) Beaufort L et al., 2011, Sensitivity of coccolithophores to carbonate chemistry and ocean acidification. Nature, 476, 80-83 (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
288	6	9	44	9	47	This sentence describes suddenly local information. It looks for me in a strange because this paragraph (lines 35-47) describes global scale climate change in glacial-interglacial timescale and the responses of marine organisms. Moreover, this sentence introduces only two locations (Santa Barbara basin and Arabian Sea). If the report would like to introduce local status, two examples (Santa Barbara basin and Arabian Sea) are not enough. Alternatively, this sentence should be deleted from this paragraph. (Harada, Naomi, Japan Agency for Marine-Earth Science and Technology)
289	6	9	49	9	49	delete "today's" and replace with "that of today" (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
290	6	9	49	9	54	What was change in aragonite saturation state during the Pliocene warm period? (UNITED STATES OF AMERICA)
291	6	9	49	10	2	Please rewrite and expand this paragraph. It is confusing because it mixes different processes [range expansion vs extinction] and different taxonomic groups. Authors may also reconsider why it is most appropriate for this section, since Pliocene CO2 estimates have high error bars and very low temporal resolution, pH is not well known. 3 Ma was not a warming "trend", it was actually in a series of cooling steps. Planktonic should be changed to planktic foraminiferal species. The macrofaunal evolutionary data are poorly constrained in terms of age [delete these]. The paragraph mixes climate modeling, surface ocean SST reconstruction, macrofaunal paleontology, but lacks reference to many other studies of Pliocene climate. As written, the text does not do justice to the topic . (UNITED STATES OF AMERICA)
292	6	9	50	9	50	microatm do not equal ppm. Suggest removing "= ppm". (UNITED STATES OF AMERICA)

#	Ch	From Page	From Line	To Page	To Line	Comment
293	6	9	51	9	51	For the described warming trend, it would be helpful to specify the overall amount of warming that occurred over the mentioned several tens of thousands of years. (Mach, Katharine, IPCC WGII TSU)
294	6	9	53	9	54	Delete “ However no” to give “... (high confidence). Increases in species....” (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
295	6	9	54	9	54	replace "has" with "have" (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
296	6	10	4	0	0	Term PETM is already defined on Page 9, line 25 so might not need to be redefined in this sentence. (Ambulkar, Archis, Brinjac Engineering Inc.)
297	6	10	4	1	4	...future ocean, apart the extreme Cretaceous/Tertiary boundary, is the... (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
298	6	10	4	10	7	Please rewrite this run-on confusing sentence. It appears that some references on rate of CO2 release during PETM are missing. (UNITED STATES OF AMERICA)
299	6	10	4	10	21	General comment – some very long sentences needing to be split up for clarify meaning. (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
300	6	10	5	10	5	PETM...an event of rapid warming (in 10-20 000 years) (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
301	6	10	5	10	5	Grammar check to give “... acidification. Although model...” (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
302	6	10	6	1	6	10-100 time higher (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
303	6	10	8	10	8	Presumably this model projection was for change during the PETM? It could be helpful to clarify this. (Mach, Katharine, IPCC WGII TSU)
304	6	10	8	10	9	It is unclear whether the model is projecting ocean acidification during the PETM or at present. If it is looking at the PETM, then it is unclear why the pH change is similar to that predicted for the present, given the difference in atmospheric carbon dioxide levels between the two periods. Please clarify. (AUSTRALIA)
305	6	10	12	10	12	“... (6.2.2.-3). There...” new sentence (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
306	6	10	13	10	14	Change to “In contrast, in the benthic ecosystem a 50% extinction among benthic foraminifera was recorded....” (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
307	6	10	13	10	14	General comment – an ecosystem does not record on extinction. (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
308	6	10	17	10	17	delete "larger". Foraminifera are no larger than the algae and corals (Lovejoy, Connie, Université Laval)
309	6	10	18	10	20	What are the lessons we take from this historical information? (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
310	6	10	22	10	29	OAE's are extremely important in the context of OA. It is recommend that this section be expanded significantly, including discussion of alternative ocean mechanisms for OAE oxygen depletion, ages and patterns for each OAE, global vs regional scale of OAEs. (UNITED STATES OF AMERICA)
311	6	10	26	10	27	insert comma after “radiolarian),” (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
312	6	10	27	10	27	change parenthesis to “(e.g. coccolithophores, maximum 7%, Leckie et al., 2002)” (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
313	6	10	31	10	31	Change first sentence to say “For examples of collapse of marine ecosystems at global scale, delving into....” (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
314	6	10	35	10	35	Change “though” to “Although” to give “...depletion. Although the rate of...” (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
315	6	10	37	10	37	(Wood, 1999 Wood R, 1999, Reef evolution. Oxford Univ Press, UK, 254pp (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
316	6	10	42	10	43	only the deep time" older that 33 Ma" - what is "deep time"? I don't know! (Head, Erica, Fisheries and Oceans Canada)

#	Ch	From Page	From Line	To Page	To Line	Comment
317	6	10	42	10	43	Where projected levels for this decade and century are obliquely referred to, it could be clearest to present the specific relevant values within parentheses. (Mach, Katharine, IPCC WGII TSU)
318	6	10	42	10	44	The text needs a caveat that pre 800- ka CO2 estimates have large error bars, so statements should be less definitive i.e. as far as proxy paleo-CO2 data show to date, but research on proxies is badly needed. (UNITED STATES OF AMERICA)
319	6	10	42	10	54	This paragraph misses an important point. The slower rate of change in the past not only enabled some biological adaptation to take place but it also enabled CaCO3 compensation, effectively decoupling saturation state from CO2. This is explained well in Zeebe R. E. & Ridgwell A., 2011. Past changes of ocean carbonate chemistry. In: Gattuso J.-P. & Hansson L. (Eds.), Ocean acidification, pp. 21-40. Oxford: Oxford University Press. (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
320	6	10	47	10	49	The sentence beginning 'The unparalleled rate...' is written in a way that implies that the ocean has been undergoing acidification for the last 300 Myr. Please re-phrase to make this sentence clear. (AUSTRALIA)
321	6	10	47	10	49	Please reword awkward sentence. Since this is early in the chapter, give the rate of OA. (UNITED STATES OF AMERICA)
322	6	10	48	10	48	...Earth history (apart the asteroidal Cretaceous/Tertiary event). (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
323	6	10	48	10	48	delete "modern" replace with contemporary or current? (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
324	6	10	48	10	48	insert "unprecedented" to give "...acidification unprecedented in at least..." (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
325	6	10	51	10	54	As far as we know the modern rate is unprecedented, but in fact we don't have high resolution paleo-CO2 or paleo-pH records from all the geological periods discussed above. While highly unlikely, and mechanisms would be hard to pinpoint [volcanism, ocean degassing, etc], we do not absolutely know how rapid CO2 injections of the past were. (UNITED STATES OF AMERICA)
326	6	10	52	10	52	Edit to say "...climate change is compared to the ..." (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
327	6	10	54	10	54	insert "many" to say "...many marine organisms" (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
328	6	11	3	0	0	Section 6.1.3 is more a listing of observations and lacks concise information about what has been learned. The discussions in this section should be expanded to include specific detail on the topics. (UNITED STATES OF AMERICA)
329	6	11	5	11	7	I do not think mention of paleo-obs is relevant here. The main point with reference to Table 6.1 is the lack of long-term observational records of biological/ecological processes in the oceans. (Lough, Janice, Australian Institute of Marine Science)
330	6	11	5	11	9	Please rewrite sentence and define "long-term". As it reads, It sounds like terrestrial paleo-records are better known than ocean records. It is the other way around. Also as it reads it mixes paleo-records with "data sets of oceanic phenomena", not ocean sediment records of biological systems. (UNITED STATES OF AMERICA)
331	6	11	6	11	6	...tree rings, coral bands, (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
332	6	11	6	11	6	It seems that "long-term" data sets are meant here, which could be clarified. (Mach, Katharine, IPCC WGII TSU)
333	6	11	10	11	11	The sentence beginning 'The undersampling...' could be more specific - what specifically can we not make 'meaningful assessments' about? (AUSTRALIA)
334	6	11	13	11	15	Table 6-1 (page 124) with regard to satellite chlorophyll data it would be good to mention that the Coastal Zone Colour Scanner (1978-1986) existed before SeaWiFS. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)

#	Ch	From Page	From Line	To Page	To Line	Comment
335	6	11	14	11	15	Comment on table 6.1. The Plymouth time series from the early 1900s should be mentioned here (Southward 1980, Southward et al., 1995, 2005; Hawkins et al., 2003). Although interrupted it has given many insights on responses of marine ecosystems to climate fluctuations and now rapid climate change. Southward AJ. 1980. The Western English Channel – an inconstant ecosystem? Nature 258: 361-366. Southward AJ, Hawkins SJ, Burrows MT. 1995. Seventy years' observations of changes in distribution and abundance of zooplankton and intertidal organisms in the western English Channel in relation to rising sea temperature. Journal of Thermal Biology 20 (1-2): 127-155. Southward AJ, Langmead O, Hardman-Mountford NJ, Aiken J, Boalch GT, Dando PR, Genner MJ, Joint I, Kendall M, Halliday NC, et al. 2005. Long-term oceanographic and ecological research in the Western English Channel. Advances in Marine Biology 47: 1-105. Hawkins SJ, Southward AJ, Genner MJ. 2003. Detection of environmental change in a marine ecosystem – evidence from the western English Channel. Science of the Total Environment 310: 245-246. (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
336	6	11	22	11	22	Please explain what is meant by "counter-rotating". (UNITED STATES OF AMERICA)
337	6	11	25	11	29	Length of sentence makes it difficult to understand. Consider re-phrasing. (AUSTRALIA)
338	6	11	27	11	27	"the North Atlantic Oscillation Index [NAOI]" should be revised by "the North Atlantic Oscillation Index [NAOI]" (mou, lin, State Oceanic Administration of China, National Marine Data and Information Service)
339	6	11	34	11	40	Not really clear how this figure (fig 6-5) goes with the paragraph above (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
340	6	11	35	11	37	This Legend should list the places in the order they appear in the Fig, i.e. BATS, HOT, La Conruna, Monterey Bay, Cariaco Basin. (Head, Erica, Fisheries and Oceans Canada)
341	6	11	35	11	40	There is a mismatch between the Figure layout and it's caption; also suggest remove last sentence of caption - all the time series (as they are anomalies) show fluctuations between positive and negative values. (Lough, Janice, Australian Institute of Marine Science)
342	6	11	40	11	40	in figure, negative PP in blue ! (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
343	6	11	48	0	0	I suggest to introduce a very productive RADIALES project a Long-Term study in the Iberian Península, from the Bay of Biscay to the Mediterranean. The reference could be [Valdés, L, Lavín, A, Fernández de Puellas, M, Varela, M, Anadón, R, Miranda, A, Camiñas, J, y Mas, J. 2002 Spanish Ocean Observation System. IEO Core Project: Studies on time series of oceanographic data. Operational Oceanography: Implementation at the European and Regional Scale. Fleming , N.C, Vallerger, S, Pinardi, N, Behrens, H.W.A, Manzella, G, Prandle, D, Stel, J.H. (Ed.) Elsevier Science, 99-105] (Anadon, Ricardo, University of Oviedo)
344	6	11	49	0	0	"northwest of Hokkaido" is wrong. "east of Hokkaido" (MURATA, AKIHIKO, Japan Agency for Marine-Earth Science and Technology)
345	6	11	49	11	49	Could mention the ICES north Atlantic IROC (ICES Report on Ocean Climate) time-series (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
346	6	11	51	0	0	Why selecting Dore et al. for citation? It would be nice to give precedence to earlier work or just refer to WGI Ch. 3 which provides a comprehensive coverage of the time-series data. (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
347	6	12	1	12	1	With regard to satellite chlorophyll data it would be good to mention that the Coastal Zone Colour Scanner (1978-1986) existed before SeaWiFS. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
348	6	12	1	12	14	The argument of this paragraph should be more clear from the beginning. At the end of the paragraph, it comes as a surprise that the phytoplankton record isn't very useful as yet. (AUSTRALIA)
349	6	12	1	12	14	It seems to me that this paragraph is too long, considering no solid trend of NPP revealed by SeaWiFS and in-situ measurement so far. (Jung, Sukgeun, Jeju National University)

#	Ch	From Page	From Line	To Page	To Line	Comment
350	6	12	11	12	14	Pending acceptance of the BGD manuscript before the WG2 deadline, suggest to include reference to Beaulieu et al. (2012) [doi:10.5194/bgd-9-16419-2012] here. This paper follows on from Henson et al. (2010), investigating how time series discontinuities (and autocorrelation) may confound the detection of climate-driven trends in ocean chlorophyll. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
351	6	12	17	28	15	While thorough and well-written, this section focuses almost exclusively on the physiological responses and tolerances of organisms to the effects of climate change. This is an important aspect, but hardly the sole sensitivity of ecosystem diversity to climate change, as the section's title implies. Referring to other portions of Chapter 6 (e.g., p. 28, lines 50-51), Chapter 30, and elsewhere would be helpful, but more importantly it should be made clear (perhaps by renaming the section) of its limited scope. (UNITED STATES OF AMERICA)
352	6	12	21	12	41	Please consider whether this section is too general and really off the chapter's topic. (UNITED STATES OF AMERICA)
353	6	12	30	0	0	a key issues is IF and how quickly organisms can adapt (Mcleod, Elizabeth, The Nature Conservancy)
354	6	12	33	12	34	Please add a citation and more detail regarding which fish and bacteria are well studied. (UNITED STATES OF AMERICA)
355	6	12	40	12	41	Is the lack of evidence for adaption in marine, terrestrial environments, or both? (UNITED STATES OF AMERICA)
356	6	12	43	12	46	Can't quite see what this table (Table 6-2) adds (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
357	6	12	48	12	51	Sentence a bit difficult to follow. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
358	6	13	4	0	5	Here is a case where the assumption must be that the reader is clueless. (Hunt, George, University of Washington)
359	6	13	5	13	5	Should have and extra bracket, thus (CO2, nitrate, phosphate, silicate) (Head, Erica, Fisheries and Oceans Canada)
360	6	13	5	13	6	"")" needs to be added, probably after "iron" i.e. "(CO2, nitrate...including iron)" (Ambulkar, Archis, Brinjac Engineering Inc.)
361	6	13	6	13	16	The surface of the Arctic Ocean is salinity stratified and so the statement on du"temperature dependent" formation rate of the surface mixed layer is not correct for polar oceans see :Carmack, E. C. (2007), The alpha/beta ocean distinction: A perspective on freshwater fluxes, convection, nutrients and productivity in high-latitude seas, Deep-Sea Research Part li-Topical Studies in Oceanography, 54(23-26). 2578-2598. (Lovejoy, Connie, Université Laval)
362	6	13	7	0	0	Change Taboada by Gonzalez-Taboada in the reference. (Anadon, Ricardo, University of Oviedo)
363	6	13	12	13	12	net upxelling (equatorial, coastal) (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
364	6	13	13	13	13	Frontal dynamics and eddies are also causing considerable vertical transport across the photic zone (Sundby, Svein, Institute of Marine Research)
365	6	13	13	13	13	The authors should mention the important role of eddies in nutrient supply. (UNITED STATES OF AMERICA)
366	6	13	15	13	16	This sentence implies that there is variability in 'natural selection'. There may be a better way to phrase this. (AUSTRALIA)
367	6	13	16	13	16	Should 'defining' be 'declining'? (AUSTRALIA)
368	6	13	17	13	23	See above (NOTE: Comment pasted here for reference) The surface of the Arctic Ocean is salinity stratified and so the statement on du"temperature dependent" formation rate of the surface mixed layer is not correct for polar oceans see :Carmack, E. C. (2007), The alpha/beta ocean distinction: A perspective on freshwater fluxes, convection, nutrients and productivity in high-latitude seas, Deep-Sea Research Part li-Topical Studies in Oceanography, 54(23-26), 2578-2598. (Lovejoy, Connie, Université Laval)
369	6	13	20	0	0	sentence on species replacement seems speculative and uninformative. (Hunt, George, University of Washington)
370	6	13	25	13	27	Regional contexts have better be dealt in Chapter 30 of WGII. Delete Table 6-3. or move it to be combined in Chapter 30. (Jung, Sukgeun, Jeju National University)

#	Ch	From Page	From Line	To Page	To Line	Comment
371	6	13	34	13	36	perhaps there lose the point of "D" (mou, lin, State Oceanic Administration of China, National Marine Data and Information Service)
372	6	13	37	13	37	and F faunistic (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
373	6	14	2	0	5	The paragraph is related to intertidal organisms and their capacity to remain without apparent change. In the reference previously cited [Lamela et al, 2012] we shows the dramatical changes in communities dominated by Fucooids in their distributional limits. Also there are othe references related to other species and groups like in [Lima, F.P. Ribeiro, P.A. Queiroz, N. Hawkins, S. J. Santos, A.M. 2007. Do distributional shifts of northern and southern species of algae match the warming pattern?. Global Change Biology, 13: 2592-2604]. I suggest a more precautionary statement regarding changes in intertidal organisms. (Anadon, Ricardo, University of Oviedo)
374	6	14	4	14	3	It should read "temperature and salinity"...to be correct (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
375	6	14	5	0	0	"Fluctuating sea level" is sufficient [delete sea level rise]. (UNITED STATES OF AMERICA)
376	6	14	5	14	5	The reference should be WGI Ch3 and Ch13. (Plattner, Gian-Kasper, IPCC WGI TSU)
377	6	14	18	14	18	Introduction of jargon such as "ecosystem engineer" should be avoided. (UNITED STATES OF AMERICA)
378	6	14	26	14	26	Delete "organism" is taxa correct? (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
379	6	14	28	0	0	next to last word in line should be "reports" (Somero , George , Stanford University)
380	6	14	28	14	28	Delete "organism" (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
381	6	14	30	14	30	reverse order molecular to ecosystem? (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
382	6	14	35	0	38	This seems an appropriate place to mention the role of sea ice and zooplankton recruitment and its impact on fish. See Hunt et al., 2011 and Coyle et al., 2011 for examples and data from the Bering Sea. (Hunt, George, University of Washington)
383	6	14	38	14	38	rearrange order molecular to organismal effects (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
384	6	14	42	14	42	insert brackets "(i.e. bacteria and microalgae) (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
385	6	14	43	14	43	delete "e.g." replace with "such as" (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
386	6	14	47	0	0	principal, not principle (4th word in line) (Somero , George , Stanford University)
387	6	14	51	14	53	Perhaps it should be noted that not all marine macroorganisms have larval stages in their life histories. (AUSTRALIA)
388	6	15	1	15	1	replace "earth" with "Earth" (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
389	6	15	2	15	3	This sentence is unclear. Suggest re-phrasing. (AUSTRALIA)
390	6	15	6	16	30	Section 6.2.2.1 implied that temperature effects on organisms are only physiological. While for individuals, this is an important factor, it should be made clear that from individual to population levels, temperature change due to climate change has many indirect and non-physiological effects in the ocean. For example, range shifts in a population may be a response to a shift in its food, which in turn may be physiological or not (e.g., availability of nutrients. light, oxygen). (UNITED STATES OF AMERICA)
391	6	15	9	15	12	If thermal norms apply across 'organism phyla', then don't they automatically apply to bacteria, phytoplankton, higher plants, etc? (AUSTRALIA)

#	Ch	From Page	From Line	To Page	To Line	Comment
392	6	15	19	15	38	There are a lot of concepts and jargon packed into this figure legend (6-7) and the figure itself. The legend needs clarification in some sections. The sentence (line 34 and following) , "Species display maximum productivity in southern spring..." should be rewritten/simplified in the interests of clarity. Obviously, productivity is seasonal in all habitats, so couldn't a simpler statement be presented here? Line 29: "reflects" to agree with singular subject ("shift"). (Somero , George , Stanford University)
393	6	15	34	15	34	It should read "In the northern hemisphere species display maximum productivity in the south during spring" ...to be correct (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
394	6	15	40	16	17	Principles of temperature effects; specifies effects on animals breathing water (l40 et seq) but needs to address air-breathing animals; not mentioned until 6.2.5.5 "Sensitivities" (Diamond, Antony, University of New Brunswick)
395	6	16	8	16	9	This sentence is difficult to understand, suggest rephrasing. (AUSTRALIA)
396	6	16	10	16	10	Poloczanska et al., 2008 relevant here Poloczanska ES, Hawkins SJ, Southward AJ, Burrows MT. 2008. Modelling the response of populations of competing species to climate change. Ecology 89 (11): 3138-3149. (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
397	6	16	14	16	17	"Mechanism-based insights" etc: add example of Cairns et al. 2008 (see comment on p. 27 l 14 below), scaling up from physiological responses of ectotherms & endotherms to biogeographic distribution patterns related to SST (Diamond, Antony, University of New Brunswick)
398	6	16	25	0	0	Is the 122C-tolerant microbe a member of the Thermotogales or does it belong to the domain Archaea? (Somero , George , Stanford University)
399	6	16	33	0	0	May be delete "in ocean acidification" (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
400	6	16	33	17	10	The same comment (from comment 49206) applies for the acidification section 6.2.2.2. (UNITED STATES OF AMERICA)
401	6	16	35	0	0	Ocean Acidification (OA) is already defined on Page 7, line 21, so need not to be defined again in the sentence. (Ambulkar, Archis, Brinjac Engineering Inc.)
402	6	16	40	16	42	The metaanalysis of Liu et al. (2010; Aquatic Microbial Ecology) is missing. Anyway, I recommend to cite only one of the metaanalysis paper (Kroeker et al., 2013). The reason is that it involved the two main previous groups (Kroeker, Hendriks, Gattuso) and resolves the conflicting conclusions of the previous analyses by using a standardized approach. (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
403	6	16	44	0	0	not clear what word "compartments" refers to (McLeod, Elizabeth, The Nature Conservancy)
404	6	16	44	16	44	It is not clear what 'compartments' refers to - does it refer to body compartments? Please clarify (AUSTRALIA)
405	6	16	44	16	44	To further support this statement, it would be preferable to also provide citations beyond the FAQ reference. (Mach, Katharine, IPCC WGII TSU)
406	6	16	50	16	51	Insertions thus "The formation of carbonate from bicarbonate is essential in calcification, which is the formation of calcified structures built by the deposition of solid CaCO ₃ , and which is used etc." (Head, Erica, Fisheries and Oceans Canada)
407	6	17	5	0	0	Space needed after word "levels" (Ambulkar, Archis, Brinjac Engineering Inc.)
408	6	17	5	0	0	The dissolution of mollusks was clearly shown near CO ₂ vents by Rodolfo-Metalpa R., Houlbrèque F., Tambutté É., Boisson F., Baggini C., Patti F. P., Jeffree R., Fine M., Foggo A., Gattuso J.-P. & Hall-Spencer J. M., 2011. Coral and mollusc resistance to ocean acidification adversely affected by warming. Nature Climate Change 1:308-312. (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
409	6	17	6	17	24	Table 6-5. A representative value of atmospheric pCO ₂ at present need to be cited here for comparison with the projected levels (for example, ~400 micro-atm in 2013) (Jung, Sukgeun, Jeju National University)

#	Ch	From Page	From Line	To Page	To Line	Comment
410	6	17	10	17	10	Insert the phrase "...unidentified, although see the recent study by Pespeni et al 2013 [PNAS 110: (17) 6937-6942]". (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
411	6	17	16	17	16	Should be "Not all life stages, nor all parameters, nor the entire range etc." (Head, Erica, Fisheries and Oceans Canada)
412	6	17	27	17	39	Regarding the hypoxia section 6.2.2.3: Section 6.2.2.1 implied that temperature effects on organisms are only physiological. While for individuals, this is an important factor, it should be made clear that from individual to population levels, temperature change due to climate change has many indirect and non-physiological effects in the ocean. For example, range shifts in a population may be a response to a shift in its food, which in turn may be physiological or not (e.g., availability of nutrients. light, oxygen). (UNITED STATES OF AMERICA)
413	6	17	29	17	29	The definition of hypoxia is different than previous pages. The whole chapter should be checked for consistent use of the term hypoxia. It occurs elsewhere, for example, on p. 23, line 23 (UNITED STATES OF AMERICA)
414	6	17	42	18	7	Section 6.2.2.4 is not that relevant or informative and could be considered for deletion. (UNITED STATES OF AMERICA)
415	6	17	45	0	0	Has the conjecture that elevated CO2 influences sound propagation been supported or refuted? It's my understanding that this putative CO2 effect does not occur, but I'm not an expert here. It would be good to check on the current status of this idea. (Somero , George , Stanford University)
416	6	17	45	17	46	Is the sound propagation effect ever likely to be biologically meaningful? Other citations, perhaps on impacts to marine mammals and echolocation? (UNITED STATES OF AMERICA)
417	6	17	48	17	48	Should this sentence refer to all marine reptiles, rather than just turtles? (AUSTRALIA)
418	6	17	53	18	7	This section could be improved by linking terrestrial impacts on the resilience of air breathing animals, with reference to the terrestrial chapter. Although the sentiment reflects greater resilience among air breathing animals, the point around habitat structure resilience or loss could be linked to terrestrial impacts of climate change. (AUSTRALIA)
419	6	18	0	0	0	Figure 6-9: Reference to figure 6-10 is made on p 16, before reference to figure 6-9. Figures will need to be renumbered and ordered. (UNITED STATES OF AMERICA)
420	6	18	1	18	2	availability of prey or other, including" - this makes no sense - other what? (Head, Erica, Fisheries and Oceans Canada)
421	6	18	3	18	3	Bowhead whales in the Arctic should be added to this list since they use ice to avoid predation by Killer whales at certain times of the year: Ferguson, S. H., L. Dueck, L. L. Loseto, and S. P. Luque (2010), Bowhead whale Balaena mysticetus seasonal selection of sea ice, Mar. Ecol.-Prog. Ser., 411, 285-297. (Lovejoy, Connie, Université Laval)
422	6	18	10	18	24	The paragraph, including Figure 6.9, gives the impression that the future change of influences light, stratification and wind mixing (e.g. storms) in a uniform way across the world oceans. That is not. The way climate change impacts the regional scale is diverse, and in fact, in some regions of the world the future could go the opposite way. Regarding the mechanisms in Figure 6.9: I have problems to understand that more dust (on land ?) will significantly influence ocean productivity (except for increased iron fertilization) and that increased stoms reduce nutrient supply. (Sundby, Svein, Institute of Marine Research)
423	6	18	15	18	15	Take out the "both", since at least three factors are listed (Head, Erica, Fisheries and Oceans Canada)
424	6	18	21	18	21	Reference to the 'productivity' of heterotrophic organisms is confusing - Is there a better way to describe this? (AUSTRALIA)
425	6	18	29	18	35	The sections under 'Mechanisms and Principles of Climate Change Impacts across Organism Taxa' provide a very technical description which is difficult to follow at times. The section could be improved by using the Conclusions section to more clearly highlight the key points. (AUSTRALIA)
426	6	18	30	18	30	Confidence level not needed for this statement. (UNITED STATES OF AMERICA)

#	Ch	From Page	From Line	To Page	To Line	Comment
427	6	18	31	18	32	There is inconsistency within the chapter on the subject of scaling up experimental results. Lines 31-32 discuss that experiments can't really be scaled up. Other places in this chapter (particularly with reagrd to OA) discuss results that are scaled all the way from experiments to ecosystems - need to be consistent with stand on scaling of experimental results (and appropriately cautious of extrapolations). (UNITED STATES OF AMERICA)
428	6	18	33	18	33	No confidence statement is needed for this sentence. (UNITED STATES OF AMERICA)
429	6	18	38	18	38	The chapter never mentions marine viruses. Admittedly hardly anything is known about them, much less how they respond to climate change, but they are the most numerous biological entities in the sea so should at least be acknowledged. (UNITED STATES OF AMERICA)
430	6	18	43	18	45	The sentence that begins "Microorganisms also catalyze " appears twice. (Head, Erica, Fisheries and Oceans Canada)
431	6	18	43	18	45	Repetition (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
432	6	18	43	18	45	The accidental repetition of the sentence here should be remedied. (Mach, Katharine, IPCC WGII TSU)
433	6	18	44	0	0	A sentence is duplicated here. (Somero , George , Stanford University)
434	6	18	44	18	44	Repeated sentence. Remove duplicate text. (UNITED STATES OF AMERICA)
435	6	19	1	19	1	This paragraph appears to use microbe and phytoplankter interchangeably. Use consistent terminology. (UNITED STATES OF AMERICA)
436	6	19	6	19	7	Addition and deletion, thus " warmer waters (Morán et al. 2010), although this may be partly a response to nutrient limitation, since there is generally an association between higher temperatures and lower nutrient availability (Marañón et al., 2012). Further experimental and field observations " Reference: Marañón, E., Cermeño, P., Latasa, M. Tadolnéké, R.D. (2012) Temperature, resources, and phytoplankton size structure in the ocean. Limnol. Oceanogr. 57(5), 1266-1278 (Head, Erica, Fisheries and Oceans Canada)
437	6	19	6	19	7	It would be helpful to specify the general time frame for this statement. (Mach, Katharine, IPCC WGII TSU)
438	6	19	7	19	7	Delete "However" start sentence with "Further" (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
439	6	19	8	19	8	Insert "however" to give "...are , however, required..." (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
440	6	19	12	19	12	replace "phytoplankter" with phytoplankton (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
441	6	19	19	19	19	Confidence level not critical for this statement. (UNITED STATES OF AMERICA)
442	6	19	29	19	34	Ardyna, M., M. Gosselin, C. Michel, M. Poulin, and J. E. Tremblay (2011), Environmental forcing of phytoplankton community structure and function in the Canadian High Arctic: contrasting oligotrophic and eutrophic regions, Marine Ecology-Progress Series, 442, 37-57. (Lovejoy, Connie. Université Laval)
443	6	19	29	19	34	Using the same data others (Hill et al. 2013) have found that the trend is the opposite of Arrigo and van Dijken(2011). The thought is that CDOM was not accurately modeled. Ardyna et al (2011) also point out the fact that surface chl a does not indicate the state of the Arctic productivity since most production is deeper than what satilites detect (Lovejoy, Connie, Université Laval)
444	6	19	31	0	0	Should the value be "8.1" instead of "8,1" (Ambulkar, Archis, Brinjac Engineering Inc.)
445	6	19	32	19	33	Sentence beginning 'in addition' could be clearer. Suggest re-phrasing. (AUSTRALIA)
446	6	19	35	19	36	Krill eat free-floating phytoplankton quite happily, so the sentence that begins "As some krill etc." is inappropriate. It should be omitted or replaced thus: "Antarctic krill and their larvae rely on ice biota and the dense phytoplankton blooms that appear as the ice melts, and the under-ice habitat also provides refuge from predators. Reduced ice-cover and changes in phytoplankton dynamics may lead to lower recruitment rates for this species (low confidence), which would have a significant impact on the Antarctic ecosystem (Smetacek and Nicol, 2005)." (Head, Erica, Fisheries and Oceans Canada)

#	Ch	From Page	From Line	To Page	To Line	Comment
447	6	19	36	0	0	There are a number of papers that have come out from the recent Bering Sea work that could be relevant here. Deep Sea Research II (Hunt, George, University of Washington)
448	6	19	39	20	18	The paragraph "Stratification – nutrient and irradiance controls primary production" refers to Fig. 6-9. Mechanisms indicated in this fig. and in the text are not obvious and appears wrong to me. E.g. the FUTURE cartoon in Fig. 6-9 indicates that the euphotic zone will be shallower than in the NOW cartoon (as indicated by the shallower light penetration in the FUTURE than in the NOW situation). Why? Reduced vertical nutrient supply is also indicated in "FUTURE". Published studies, as well as common sense, suggest that reduced nutrient transport results in a deeper, and not a shallower, euphotic zone as observed in the oligotrophic ocean. This is simply due to less light attenuation from phytoplankton because of less primary production in upper water and therefore a deeper light penetration, deeper primary production, and deeper nutricline (i.e. the opposite of what is illustrated in Fig. 6-9). Only if another substance than phytoplankton is the dominant light attenuator (such as CDOM and inorganic particles in e.g. coastal areas) and this attenuator increases from NOW to FUTURE we should expected shallower light penetration, euphotic zone, and nutricline. Since a deeper euphotic zone means deeper nutricline and deeper location of the primary production, the oxygen production at depth is also likely to be higher than in the case of a shallow euphotic zone and a shallow primary production (which is in contrast to Fig. 6-9). It appears as if part of the text in Chapter 6 and Fig 6-9 assumes that the depth of the euphotic zone coincides with the depth of the mixed layer. Generally this is not the case. (Aksnes, Dag Lorents, University of Bergen)
449	6	19	41	19	51	The progression of the argument in this paragraph is unclear. Suggest re-phrasing. (AUSTRALIA)
450	6	19	42	19	44	Lower chlorophyll concentrations etc Firstly, this sentence is ambiguous. Is it trying to say that the sub-tropical gyres, which are warm, have lower chlorophyll concentrations than other areas? Or is it talking about the trends over time for chlorophyll and SST at low latitudes being negatively related? (Head, Erica, Fisheries and Oceans Canada)
451	6	19	42	19	44	Secondly, although the phrase "based on ocean color" appears here, it may not be appropriate. Most people these days would think that "ocean color" refers to what is seen by satellites. Boyce et al. did not use satellite data. Also, I am not convinced that Boyce et al. were the first to make the connection between decreasing chlorophyll concentrations and increasing SST in the subtropical gyres. For example, Gregg et al. (2005) and Behrenfeld et al. (2006) discuss the relationship between trends in chlorophyll concentration (or NPP) and SST, albeit over a shorter time scale. I would replace this sentence thus: "Chlorophyll concentrations have decreased in nutrient-poor low latitude waters over the last two (Gregg et al., 2005; Behrenfeld et al., 2006) or more decades (Boyce et al. 2010), as sea surface temperatures have been increasing, and this has been interpreted as an effect of increased stratification on phytoplankton production." (Head, Erica, Fisheries and Oceans Canada)
452	6	19	42	19	44	So, I might replace this material thus "In contrast, at higher latitudes, in areas where light, rather than nutrients, limits phytoplankton growth, increasing sea surface temperatures within the last several decades led to increased stratification, reduced mixed layer depths and increased chlorophyll concentrations (Richardson and Shoeman, 2004; Boyce et al. 2010)." (Head, Erica, Fisheries and Oceans Canada)
453	6	19	42	19	44	"Over the long-term (last 100 years) it has been suggested that there has been 1% per year decline in phytoplankton biomass on a global scale (Boyce et al., 2010), although this idea has not been generally accepted (e.g. McQuatters-Gollop et al., 2011; Mackas, 2011; Rykaczewski and Dunne, 2011)." (Head, Erica, Fisheries and Oceans Canada)
454	6	19	42	19	46	Boyce et al (2010): This is a paper with results and conclusions strongly questioned in many published comments and in a very large number of unpublished comments. (Sundby, Svein, Institute of Marine Research)

#	Ch	From Page	From Line	To Page	To Line	Comment
455	6	19	45	19	46	In contrast higher chlorophyll concentrations Positive relationships between SST and chlorophyll concentration at higher latitudes appear to be more widespread in the southern than in the northern hemisphere, and there seems to be broad agreement among authors on this. In the northern hemisphere results are not straightforward. For example, in the NE Atlantic between latitudes 45 and 60oN Vantrepotte and Melin (2011), using satellite data, showed a significant downward trend in chlorophyll concentration between 1997 and 2007, a period during which SSTs were increasing. By contrast, over the same period and in the same region, McQuatters et al. (2011), using CPR sampling, found little change in the relatively low phytoplankton (PCI) levels. In the NW Atlantic (N of 50oW), where SSTs were also increasing between the mid-1990s and mid-2000s, McQuatters et al. (2011) found little change in phytoplankton biomass, which was at relatively high levels. As well, Head and Pepin (2010) found no change in satellite-based chlorophyll concentrations between 1998 and 2006, and increases in the CPR-derived phytoplankton biomass, for several sub-regions in the NW Atlantic N of 55oN. Overall, it seems that trends are spatially and temporally variable and that generalizations are of dubious value, based on the available time series. (Head, Erica, Fisheries and Oceans Canada)
456	6	20	3	20	3	Change "across" to "throughout" (Head, Erica, Fisheries and Oceans Canada)
457	6	20	4	20	4	Should it say "resident" rather than "residence"? (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
458	6	20	6	20	7	Boyce et al. (2010) did not make any strong predictions (projections) into the future and neither did any of these three "Brief communications". Instead, they questioned the contention of Boyce et al. (2010) that there has been a global decline in phytoplankton biomass of 1% per year over the last 100 years. So, the authors of this part of the text have got it wrong! In addition, there have been many more comments made by highly regarded scientists criticizing the Boyce et al. (2010) paper. So, I would suggest either omitting this first sentence, or replacing it with the following: (Head, Erica, Fisheries and Oceans Canada)
459	6	20	10	20	14	The paragraph (line 7-10) are focussing on the weakness of interpreting climate change from time series shorter than 20 years. I absolutely agree, and I would extend it also to be valid for time series shorter than 50 years. However, how can you then explain this to be caused by both climate change and anthropogenic eutrophication and neglect the most obvious cause, namely natural climate variability? (Sundby, Svein, Institute of Marine Research)
460	6	20	15	0	0	should something that is only putative be in this document. Is this result not believed? (Hunt, George, University of Washington)
461	6	20	23	0	0	Ocean Acidification (OA) is already defined on Page 7, line 21, so need not to be defined again in the sentence. (Ambulkar, Archis, Brinjac Engineering Inc.)
462	6	20	26	20	26	...carbon-concentrating mechanism of bicarbonate, CCM's (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
463	6	20	33	20	34	This sentence sends a confusing message. Kroeker et al. (2013) have shown that overall, calcification was negatively affected by ocean acidification. This is significant, also for coccolithophores. Hence, I do not understand why this should be "high evidence medium agreement" (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
464	6	20	33	20	44	Note that there could be several reasons explaining conflicting results. These are outlined in an IPCC report. Gattuso J.-P. & Riebesell U., 2011. Reconciling apparently contradictory observations. In: Field C. B., Barros V., Stocker T. F., Qin D., Mach K. J., Plattner G.-K., Mastrandrea M. D., Tignor M. & Ebi K. L. (Eds.), Workshop report of the Intergovernmental Panel on Climate Change workshop on impacts of ocean acidification on marine biology and ecosystems, pp. 10-16. Stanford, California: IPCC Working Group II Technical Support Unit, Carnegie Institution. (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
465	6	20	36	20	36	Should it say "to estimate" rather than to be estimated"? (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
466	6	20	41	20	41	Add: <i>Emiliana huxleyi</i> is a particular species as it blooms in subpolar water, contrary to all other photosynthetic marine calcifiers (Pecheux, Martin, Institut des Foraminifères Symbiotiques)

#	Ch	From Page	From Line	To Page	To Line	Comment
467	6	20	41	20	41	It would be useful to remind the audience how climate change might influence nitrogen limitation and light levels. (AUSTRALIA)
468	6	20	44	20	44	Add: Almost nothing is known on effect of OA on competition fitness at ecosystem level. (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
469	6	21	5	0	0	define CCMs- and get rid of acronyms! (Hunt, George, University of Washington)
470	6	21	6	21	7	I disagree with the conclusion. Most nitrogen fixation is performed in open waters, not in coastal seas. Hence, giving a low confidence and medium agreement based on one paper on a coastal cyanobacteria from the Baltic Sea seems unreasonable. I agree though that evidence is limited, especially in situ where the only study reported no stimulation of nitrogen fixation under elevated pCO ₂ (Law C. S., Breitbarth E., Hoffmann L. J., McGraw C. M. & Langlois R.J. L. J., Marriner A. & Safi K.A, 2012. No stimulation of nitrogen fixation by non-filamentous diazotrophs under elevated CO ₂ in the South Pacific. Global Change Biology 18:3004-3014.) (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
471	6	21	39	22	14	The paragraph: "6.2.4 Macrophytes – Effects of temperature and ocean acidification" could also include effects of changed underwater light regime (as treated by the authors in "6.2.3.2 Irradiance" and elsewhere in Chapter 6). Since the vertical zonation and the extension of the macrophyte habitat, and the associated rich biodiversity, is directly related to the light regime and light attenuation properties. E.g. a decrease in the euphotic zone as indicated in Fig. 6-9 leads to the expectation of a shallower, but also less, vertical habitat for macrophytes and vice versa. In particular since macrophytes commonly are distributed in coastal areas climate change associated increases in colour dissolved organic matter (CDOM) from terrestrial and freshwater systems (sometimes referred to as brownification) that drains to coastal waters are likely to be of relevance for the light climate and changes of macrophyte habitats and their associated biodiversity. (Aksnes, Dag Lorents, University of Bergen)
472	6	21	41	0	0	What about the role of sea ice in scouring off macrophytes? With decreasing sea ice, macrophytes are likely to extend their ranges poleward (Hunt, George, University of Washington)
473	6	21	41	0	0	Macrophytes are not in the "transition zone to coastal waters", they are in coastal waters. (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
474	6	21	43	0	0	Reference to Fig. 6-7 should be removed as this figure does not address macrophytes (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
475	6	21	47	0	0	Acclimation, rather than acclimatization? (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
476	6	22	1	0	0	Add a link to 5.4.2.3, where this issue is covered with more detail. (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
477	6	22	1	22	14	Note that the meta-analysis of Kroeker et al. (2013) found no significant effect of ocean acidification on calcification and a significant decline of photosynthesis, which is at odds with this section. (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
478	6	22	7	0	0	Also Martin S. & Gattuso J.-P., 2009. Response of Mediterranean coralline algae to ocean acidification and elevated temperature. Global Change Biology 15:2089-2100. (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
479	6	22	7	22	7	...increased under normal temperature with rising CO ₂ (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
480	6	22	12	22	12	The statement "...macrophytes specialize on limited temperature ranges..." is confusing. Please clarify meaning. (UNITED STATES OF AMERICA)
481	6	22	12	22	14	The expectation that macrophytes (seaweeds and seagrasses) will be more competitive than calcifying organisms in a high CO ₂ ocean is an important conclusion. As currently worded, this paragraph is not particularly clear at getting this information across. This point should also be included in the Executive Summary. (AUSTRALIA)

#	Ch	From Page	From Line	To Page	To Line	Comment
482	6	22	14	0	0	This sentence exemplifies the difficulty of evaluating the “benefit” of an effect because it implies biases and judgment not based on experimental or statistical evidence. When one function is stimulated (photosynthesis) and another one inhibited (calcification) is the overall effect beneficial or detrimental? I would do without trying to assess the benefit in such a case. (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
483	6	22	19	0	0	The reference to turtles to explain the effect on marine ectotherms probably is not a good example. At least Leatherback turtle could maintain a higher emperature than environmental temperature. [Frair, W., Ackman, R.G., Mrosovsky, N. 1972. Body temperature of Dermochelis coriacea warm turtle from cold waters. Science 177: 791-793] (Anadon, Ricardo, University of Oviedo)
484	6	22	19	22	22	It could be useful to have these definitions of ectotherms and endotherms earlier in the chapter. (AUSTRALIA)
485	6	22	26	0	0	Among the climatic indices, it is worth mentioning the WeMOi index in the W Mediterranean, which affects landings of small pelagics. See e.g. Martín et al. 2012. Climatic Change 110:925-939 (LLORET, JOSEP, UNIVERSITY OF GIRONA)
486	6	22	26	22	54	This section could benenefit from evidence of documented range shifts. However, this information is found in Chapter 30. Somehow the authors need to reconcile content of the chapters to prevent reduncancy or potential contradiction. (UNITED STATES OF AMERICA)
487	6	22	29	22	29	Should be: AMO and NAO (Sundby, Svein, Institute of Marine Research)
488	6	22	39	22	39	Would be good to cite Simpson et al (2011b) - already included in the reference list. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
489	6	23	0	0	0	General comment – Might be worth stating that in the intertidal and water species. In North Atlantic tend to grow faster and outcompete southern species – except when warming releases southern species from competition (Poloczanska et al., 2008). Poloczanska ES, Hawkins SJ, Southward AJ, Burrows MT. 2008. Modelling the response of populations of competing species to climate change. Ecology 89 (11): 3138-3149. (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
490	6	23	4	23	5	Atlantic cod stocks at the northern fringe have their perfect adaptability to long-term climate variability and climate change with distributional and productivity change. Warming: northwards. Cooling: southwards. Warming: incresing prodcutivity. Cooling decreasing productivity(Drinkwater 2006; Sundby and Nakken 2008) (Sundby, Svein, Institute of Marine Research)
491	6	23	8	23	9	The link between the sentence beginning 'indirect effects' and the rest of the paragraph is unclear. Please clarify. (AUSTRALIA)
492	6	23	11	0	0	Table 6-7. Phenomenon: Northward shift in the autumn/winter distribution of North East Atlantic mackerel (Scomber scombrus) Driver: Autumn/Winter warming Mechanism / Sensitivity: Timing and position of migration is affected by temperature fluctuations within the shelf edge current. References: (Jansen et al., 2012) Jansen, T., Campbell, A., Kelly, C. J., Hátún, H., & Payne, M. (2012). Temperature, Migration and Fisheries of North East Atlantic Mackerel (Scomber scombrus) in Autumn and Winter. PLoS One, 7 (12). (Jansen, Teunis, Danish Technical University - National Institute of Aquatic Resources)
493	6	23	11	23	13	Table 6-7 - Would be good to cite Simpson et al (2011b) - already included in the reference list. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
494	6	23	41	21	41	In cod, different haemoglobin polymorphisms exist, some of which are more apparent in northerly cooler areas and others in southerly, warmer areas (Behrens et al 2012, JEMBE Vol 413). (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)

#	Ch	From Page	From Line	To Page	To Line	Comment
495	6	24	1	0	0	In this section on OA, a new reference would seem worth including. A recent paper by Pespini et al. in PNAS shows that genetic variation in the purple sea urchin may allow sufficient material for selection to lead to less OA-sensitive populations over relatively short time intervals. The reference is: Pespini, M.H., E. Sanford, B. Gaylord, T.M. Hill, J.D. Hosfelt, H.K. Jaris, M. LaVigne, E.A. Lenz, A.D. Russell, M.K. Young, and S.R. Palumbi (2013). Evolutionary change during experimental ocean acidification. DOI: www.pnas.org/cgi/doi/10.1073/pnas.1220673110 . (Somero , George , Stanford University)
496	6	24	15	24	17	The sentence 'but also enhanced energy efficiency under CO2' should read 'but also enhanced energy efficiency under increased CO2 conditions'. (AUSTRALIA)
497	6	24	18	24	19	The last sentence needs to be written in relation to variability in carbon dioxide. (Jung, Sukgeun, Jeju National University)
498	6	24	25	24	26	Sentence needs to be revised properly to adjust "comma" and "(" (Ambulkar, Archis, Brinjac Engineering Inc.)
499	6	24	30	24	46	Not clear in the figure caption (fig 6-10) if this is based on a meta-analysis or modelling??? Also is it permissible to include reference to a submitted rather than published source? (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
500	6	25	3	25	3	What about 'bottom up' food-web impacts on fish? (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
501	6	25	8	0	0	I would add Bednars'ek N., Tarling G. A., Bakker D. C. E., Fielding S., Jones E. M., Venables H. J., Ward P., Kuzirian A., L���� B., Feely R. A. & Murphy E. J., 2012. Extensive dissolution of live pteropods in the Southern Ocean. Nature Geoscience 5:881��885. (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
502	6	25	8	25	8	It should read "Some species exhibited enhanced" ...to be correct (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
503	6	25	14	25	16	Requiring citations of published papers supporting the 2 sentences (Jung, Sukgeun, Jeju National University)
504	6	25	40	0	0	Interaction between temperature and ocean acidification in corals is not always due to CO2-enhanced bleaching, as shown by Reynaud S., Leclercq N., Romaine-Lioud S., Ferrier-Pag���� C., Jaubert J. & Gattuso J.-P., 2003. Interacting effects of CO2 partial pressure and temperature on photosynthesis and calcification in a scleractinian coral. Global Change Biology 9:1660-1668. (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
505	6	25	43	25	43	Please define climate zone in this section. (UNITED STATES OF AMERICA)
506	6	26	2	0	0	There is no "cold water coral reefs". They should be called "deep-sea or cold-water coral communities" because a reef is a navigational hazard. (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
507	6	26	4	0	0	Reef-building rather than tropical (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
508	6	26	4	26	19	Some highly specialized physiological information could be omitted because it is of little interest in the context of this chapter. (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
509	6	26	9	26	12	Mechanisms of mass bleaching, better to put it in Box CC-CR ! Almost all work speak now on photoinhibition of PS II. The ROS hypothesis is only mainly supported by lesser (as is contradict by degradation of D1 protein and not D2). No work support the impairment of RUBISCO as published by Jones et al., 1998, on base of one experiment very difficult to interpret. So write: ...tissue color. Damage to the symbionts involves disturbed excitation processing within the light harvesting center of photosynthesis, i.e. the photoinhibition of the photosystem II (PS II) (Hoegh-guldb���� and Smith, 1989, Glynn and D'croz, 1990, Warner, 1999), hypothetically due to reactive oxygen species (ROS) (reference wellcome) or the impairment of the CO2 fixing enzyme RUBISCO (Jones et al., 1998). (Pecheux, Martin, Institut des Foraminif����res Symbiotiques)
510	6	26	10	0	0	"disturbed excitation processsing within the light harvesting centers of photosynthesis" -- could this be stated more simply - no idea what it means (McLeod, Elizabeth, The Nature Conservancy)

#	Ch	From Page	From Line	To Page	To Line	Comment
511	6	26	13	0	14	do you mean "based on satellite observations" or "using satellite data - not clear why this is listed - is a word missing? (McLeod, Elizabeth, The Nature Conservancy)
512	6	26	13	26	15	It would be helpful to specify the general time frame for the observed change in coral abundance. (Mach, Katharine, IPCC WGII TSU)
513	6	26	15	0	0	mass bleaching is not "correlated with" an observed average decrease in coral abundance of 1-2% per year - this is what the sentence implies the way it is written - it is driven by small (OR LARGE) temperature anomalies and increased irradiance. (McLeod, Elizabeth, The Nature Conservancy)
514	6	26	17	26	17	with more tolerant but less productive varieties (refs: add van Oppen MJH and Lough JM, 2012, Coral bleaching. Patterns, processes, causes and consequences. Ecological Studies 205, Springer, Heidelberg, Berlin, 178 pp.) (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
515	6	26	21	26	22	Please also consider the information in the table of OA studies in Brainard et al. 2012 Corals ESA status review. (UNITED STATES OF AMERICA)
516	6	26	21	26	22	This sentence is a poor summary of the literature. The data from the early paper, which is not cited, of Gattuso et al. (1999. Photosynthesis and calcification at cellular, organismal and community levels in coral reefs: a review on interactions and control by carbonate chemistry. American Zoologist 39:160-183.) were used in the modeling study of Kleypas et al. (1999). Neither Leclerc et al. Nor Hoegh-Guldberg et al. Reported data on the impact of ocean acidification on coral calcification. One investigated a coral community and the second one is a review paper. (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
517	6	26	21	26	27	Manzello et al. Did not investigate a CO2 seep but regular reefs in the eastern Pacific (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
518	6	26	26	0	0	sentence beginning "heterotrophic feeding supporting resilience" should be clarified (i.e., how does heterotrophic feeding support resilience) (McLeod, Elizabeth, The Nature Conservancy)
519	6	26	26	26	27	This sentence is difficult to understand. Suggest re-phrasing. (AUSTRALIA)
520	6	26	29	26	29	Summer temperature acting... (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
521	6	26	29	26	29	A reminder of the difference between the effects of CO2 itself, and the effects of CO2 in causing ocean acidification could be useful here. (AUSTRALIA)
522	6	26	29	26	33	Interaction between temperature and ocean acidification in corals is not always due to CO2-enhanced bleaching, as shown by Reynaud S., Leclercq N., Romaine-Lioud S., Ferrier-Pagès C., Jaubert J. & Gattuso J.-P., 2003. Interacting effects of CO2 partial pressure and temperature on photosynthesis and calcification in a scleractinian coral. Global Change Biology 9:1660-1668. (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
523	6	26	29	26	33	This paragraph partly duplicates information presented earlier. (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
524	6	26	30	26	30	(Pecheux, 1993, 1998, Anthony et al., 2008...) Pecheux M, 1993, Is present coral reef mass bleaching due to CO2 rise? Proc 7th Int. Symp. Biomineralisation, 17-20 Nov. 1993, Monaco, Allemand D, Cuif JP (eds), 174. Available from www.reefbase.org or martin-pecheux.fr. Pecheux M. 1998, Review on coral reef bleaching. Atoll Res Bull. Edilivre, Paris, printed in 2013, 245 pp. Available from www.reefbase.org or martin-pecheux.fr. (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
525	6	26	30	26	31	This overarching comment relates to the SRES scenario, can a comparison to the RCP scenarios be provided as well? (AUSTRALIA)

#	Ch	From Page	From Line	To Page	To Line	Comment
526	6	26	33	0	0	Add: “, although changes in gene expression are less not as clear in coral larvae (Moya A., Huisman L., Ball E. E., Hayward D. C., Chua C. M., Woo H. N., Gattuso J.-P., Forêt S. & Miller D. J., 2012. Whole transcriptome analysis of the coral <i>Acropora millepora</i> reveals complex responses to CO2-driven acidification during the initiation of calcification. <i>Molecular Ecology</i> 21:2440-2454.) (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
527	6	26	33	26	33	I think, an additional reference with gene expression should be next to Kaniewska et al., 2012 the paper by Moya et al., 2012: Moya A, Huisman L, Ball EE, Hayward DC, Grasso LC, Chua CM, Woo HN, Gattuso J-P, Forêt S, Miller DJ (2012) Whole transcriptome analysis of the coral <i>Acropora millepora</i> reveals complex responses to CO2-driven acidification during the initiation of calcification. <i>Molecular Ecology</i> 21:2440-2454 (Maier, Cornelia, Laboratoire d'Océanographie de Villefranche sur Mer)
528	6	26	35	26	43	This paragraph would benefit from an update using recently published information. Guinotte J. M. & Davies A. J., 2012. Predicted deep-sea coral habitat suitability for the US West Coast. Report to NOAA-NMFS. http://www.marine-conservation.org/media/filer_public/2013/03/21/guinotte_davies_2012_small.pdf Maier C., Schubert A., Berzunza Sánchez M. M., Weinbauer M. G., Watremez P. & Gattuso J.-P., 2013. End of the century pCO2 levels do not impact net calcification in Mediterranean cold-water corals. <i>PLoS ONE</i> 8:e62655. Maier C., Bils F., Weinbauer M. G., Watremez P., Peck M. & Gattuso J.-P., 2013. Respiration of Mediterranean cold-water corals is not affected by ocean acidification as projected for the end of the century. <i>Biogeosciences Discussions</i> 10:7617-7640. Jantzen C., Häussermann V., Försterra G., Laudien J., Ardelan M., Maier S. & Richter C., in press. Occurrence of a cold-water coral along natural pH gradients (Patagonia, Chile). <i>Marine Biology</i> Maier C, Hegeman J, Weinbauer MG, Gattuso J-P (2009) Calcification of the cold-water coral <i>Lophelia pertusa</i> under ambient and reduced pH. <i>Biogeosciences</i> 6:1671-1680 Thresher RE, Tilbrook B, Fallon S, Wilson NC, Adkins J (2011) Effects of chronic low carbonate saturation levels on the distribution, growth and skeletal chemistry of deep-sea corals and other seamount megabenthos. <i>Mar Ecol Prog Ser</i> 442:87-99 (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
529	6	26	37	0	0	3 studies cannot provide "proof for resilience!" -- suggest rewording to "three studies demonstrate the ability of <i>L. pertusa</i> to resist changes in response to OA" or something along those lines based on what these three studies actually show. (McLeod, Elizabeth, The Nature Conservancy)
530	6	26	37	0	0	"Three studies provided proof for resilience..." This sentence overstates the evidence - implying that resilience by cold water corals has been 'proved' (i.e. a certainty). But one of the three studies cited showed high sensitivity, not resilience, and the interpretation of the other two studies is not clear-cut. Thus (as demonstrated for other organisms), resilience by <i>Lophelia pertusa</i> may only be possible if there is high food abundance - that may not be the situation under natural conditions. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
531	6	26	37	0	0	how about evidence rather than proof? (Hunt, George, University of Washington)

#	Ch	From Page	From Line	To Page	To Line	Comment
532	6	26	37	26	37	There are now six studies available, that show resilience of various cold-water coral species from different regions to OA (not only <i>L. pertusa</i>): Maier et al., 2009; Thresher et al., 2011; Form et al., 2012; Maier et al., 2012; Maier et al., 2013; Jantzen et al., 2013): Form AU, Riebesell U (2012) Acclimation to ocean acidification during long-term CO2 exposure in the cold-water coral <i>Lophelia pertusa</i> . <i>Glob Change Biol</i> 18:843-853, doi: 810.1111/j.1365-2486.2011.02583.x Jantzen C., Häussermann V., Försterra G., Laudien J., Ardelan M., Maier S. & Richter C., in press. Occurrence of a cold-water coral along natural pH gradients (Patagonia, Chile). <i>Marine Biology</i> Maier C, Hegeman J, Weinbauer MG, Gattuso J-P (2009) Calcification of the cold-water coral <i>Lophelia pertusa</i> under ambient and reduced pH. <i>Biogeosciences</i> 6:1671-1680 Maier C, Schubert A, M. B-SM, Weinbauer MG, Watremez P, Gattuso J-P (2013) End of the century pCO2 levels do not impact calcification in Mediterranean cold-water corals. <i>PLOS One</i> 8:e2655 doi:2610.1371/journal.pone.0062655 Maier C, Watremez P, Taviani M, Weinbauer MG, Gattuso J-P (2012) Calcification rates and the effect of ocean acidification on Mediterranean cold-water corals. <i>Proc R Soc Lond, B</i> 279:1713-1723 doi: 1710.1098/rspb.2011.1763 Thresher RE, Tilbrook B, Fallon S, Wilson NC, Adkins J (2011) Effects of chronic low carbonate saturation levels on the distribution, growth and skeletal chemistry of deep-sea corals and other seamount megabenthos. <i>Mar Ecol Prog Ser</i> 442:87-99 (Maier, Cornelia, Laboratoire d'Océanographie de Villefranche sur Mer)
533	6	26	38	0	0	The "()" should be removed for Maier et. Al. 2009, considering the structure of sentence. (Ambulkar, Archis, Brinjac Engineering Inc.)
534	6	26	41	26	41	Casual usage of "likely" should be avoided. (Mach, Katharine, IPCC WGII TSU)
535	6	27	1	0	0	extreme weather in addition to sea-level rise can lead to both flooding and erosion of turtle nesting beaches (Mcleod, Elizabeth, The Nature Conservancy)
536	6	27	14	27	31	What about the well documented link between changes in storminess/winds and hatching success at seabird colonies? (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
537	6	27	14	27	47	Missing is awareness of interactions between species with different temperature sensitivities in different trophic levels. Good example is Cairns et al 2008; show that biogeography of pursuit-diving seabirds and pinnipeds (endothermic) is limited by water temperature; warmer temperatures favour ectotherms (fish, squid) which may be both predators and prey of seabirds. In warmer waters, burst speed of fish increases beyond range of pursuing/fleeing seabirds and pinnipeds; there are no pursuit-diving seabirds or pinnipeds in oceans with surface temp >20° C. Warming seas will further restrict global ranges of pinnipeds and pursuit-diving seabirds. Cairns, D.K., A.J. Gaston and F. Huettmann. 2008. Endothermy, ectothermy and the global structure of marine vertebrate communities. <i>Marine Ecology Progress Series</i> 356: 239–250. doi: 10.3354/meps07286 (Diamond, Antony, University of New Brunswick)
538	6	27	21	0	0	SST term is not defined or elaborated in this chapter prior to being used in this sentence (Ambulkar, Archis, Brinjac Engineering Inc.)
539	6	27	44	27	47	This sentence implies that ice associated species will benefit from the loss of sea ice - this could be better explained. (AUSTRALIA)
540	6	27	46	27	48	But less ice would likely be bad for Bowheads and Belugas (see Ferguson et al 2010 cited above) (Lovejoy, Connie, Université Laval)
541	6	27	52	0	54	this sentence does not make any sense - are words missing? It is also a run-on and filled with too many ideas that make it difficult to understand. What does "animals specialize on restricted temperature" mean? (Mcleod, Elizabeth, The Nature Conservancy)
542	6	27	52	27	54	As written, the sentence is awkward and unfocused (UNITED STATES OF AMERICA)
543	6	27	52	28	1	The first sentence of the Conclusion is difficult to understand but seems to just say that animals have temperature tolerances and if that changes, then there are consequences. A simpler wording would be better, but more information than stating generalities one could suppose without reading the literature. (UNITED STATES OF AMERICA)

#	Ch	From Page	From Line	To Page	To Line	Comment
544	6	28	18	0	0	Section 6.3. The title of the section could be clarified based on the scope of this section and other subsection titles. That is, the section title refers to observations and attribution, but the 1st subsection refers to projections, even though projections are not much discussed in the subsection. (Mach, Katharine, IPCC WGII TSU)
545	6	28	25	28	25	Should this read "affects are accelerated..." ? (UNITED STATES OF AMERICA)
546	6	28	35	0	40	I suggest to incorporate the reference of Taylor et al, 2012. These authors shows a rapid shift in the Caribbean probably due to changes in upwelling; these change is related to the southern displacement of the Intertropical Convergence Zone and affect primary production and sardine fishery. Could be a good example of other cain of responses to climate change. Taylor, G.T., Muller-Karger, F.E. , Thunell, R.C., Scranton, M.I. , Astor, Y., Varela, R., Troccoli Ghinagliaie, L. , Lorenzoni, L., Fanning, K.A. , Hameed, S., Doherty, O. 2012. Ecosystem responses in the southern Caribbean Sea to global climate change. PNAS 109 (47) www.pnas.org/cgi/doi/10.1073/pnas.1207514109. (Anadon, Ricardo, University of Oviedo)
547	6	28	43	28	45	I would say there is no agreement that higher rates of NPP will be a hallmark of a changed Arctic see : Hill, V. J., P. A. Matrai, E. Olson, S. Suttles, M. Steele, L. A. Codispoti, and R. C. Zimmerman (2013), Synthesis of integrated primary production in the Arctic Ocean: II. In situ and remotely sensed estimates, Progress in Oceanography, 110, 107-125. (Lovejoy, Connie, Université Laval)
548	6	28	45	28	45	Are these higher NPP rates attributed to climate change? (UNITED STATES OF AMERICA)
549	6	28	50	28	51	This sentence only says temperature effects are on all the components of the ecosystem. The information is quite general and repetitive with sections in the chapter that provide more detail. (UNITED STATES OF AMERICA)
550	6	28	50	29	5	These statements are approximately key findings. The author team could consider presenting calibrated uncertainty language for them, or alternatively reducing treatment here given 6.3.7. (Mach, Katharine, IPCC WGII TSU)
551	6	29	8	30	26	Paragraph 6.3.2.1. Much of this paragraph could be shortened considerably as this is much redundant with Chapter 30 (Sundby, Svein, Institute of Marine Research)
552	6	29	10	29	10	The chapter team could consider placing "high confidence" within parentheses at the end of the sentence. (Mach, Katharine, IPCC WGII TSU)
553	6	29	22	0	0	Table 6-8. Species abundance, biogeography and diversity:: NEA mackerel aggregate and migrate along the continental shelf edge of NW Europe through autumn and winter. The main thrust of migration, delineating the northern edge of the main distribution at this time of year, follows the relatively warm shelf edge current from the northern North Sea towards the main spawning areas west of the British Isles and further south. Variation in the timing and distribution of this migration is significantly correlated to temperature changes in this current as cooling of the northern parts pushed mackerel towards south-west (Jansen et al., 2012; Reid et al., 2001; Walsh et al., 1995). Phenology: Timing of spawning and the subsequent migration of Atlantic mackerel in the North Sea is related to temperature. This significant effect was found using three independant measures and estimated to be 2, 11 and 16 days per degree celsius (Jansen and Gislason, 2011). References: Jansen T, Gislason H. (2011) Temperature affects the timing of spawning and migration of North Sea mackerel. Cont Shelf Res 31: 64-72.). Jansen, T., Campbell, A., Kelly, C. J., Hátún, H., & Payne, M. (2012). Temperature, Migration and Fisheries of North East Atlantic Mackerel (Scomber scombrus) in Autumn and Winter. PLoS One, 7 (12).). Reid DG, Walsh M, Turrel WR. (2001) Hydrography and mackerel distribution on the shelf edge west of the Norwegian deeps. Fish Res 50: 141-150. Walsh M, Reid DG, Turrel WR. 1995. Understanding Mackerel Migration Off Scotland - Tracking with Echosounders and Commercial Data, and Including Environmental Correlates and Behaviour. ICES J Mar Sci 52: 925-939. (Jansen, Teunis, Danish Technical University - National Institute of Aquatic Resources)
554	6	29	22	29	24	I would change the third item of Table 6-8, which begins "Between 1960 and 2000 the Newfoundland Shelf in the Northwest Atlantic saw an increase etc" to (Head, Erica, Fisheries and Oceans Canada)

#	Ch	From Page	From Line	To Page	To Line	Comment
555	6	29	22	29	24	"Between the 1970s and the 1990s there were increases in abundances of the arctic copepod species <i>Calanus hyperboreus</i> and <i>Calanus glacialis</i> and the dinoflagellate <i>Ceratium arcticum</i> on the Newfoundland Shelf, due to increased contribution of Arctic water, via the shelf branch of the Labrador Current." (Head, Erica, Fisheries and Oceans Canada)
556	6	29	22	29	24	I would omit the part about <i>C. hyperboreus</i> being found off Georges Bank in 1998, due to the low NAO of 1996 and flood of cool slope water around the Tail of the Grand Bank, because we had an even lower NAO in 2010 and no cold slope water came around the Tail of the Grand Bank 2 years later, so that the events of 1996-1998 were not reproduced under apparently similar conditions. This calls the mechanism described here into question, so I would omit the questionable part of the sentence! (Head, Erica, Fisheries and Oceans Canada)
557	6	29	22	29	24	Table 6-8 (bottom). You could include an almost identical line for the Northeast Atlantic citing Simpson et al (2011b) - already included in the reference list. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
558	6	29	23	29	46	The text here should have a reference to a recent paper by Valdimarsson et. al, 2012, which presents warming related northward shifts in distribution of several fish species and also records of 31 new southern fish species recorded in Icelandic waters for the first time during past 15 years. These findings and reference could also be included in Table 6.8. The relevant reference is Valdimarsson et. al, 2012. Hydrographic variability in Icelandic waters during recent decade and related changes in distribution of some fish species. ICES Journal of Marine Science, 69(5), 816-825. This reference needs to be added. See comment below (ch 6, p. 122, l. 36). (ICELAND)
559	6	29	30	0	0	mueter and Litzow did find a shift northward within the southeastern Bering, but much of this shift was shown to be from density-dependent causes; only about 30 % was attributable to warming (Hunt, George, University of Washington)
560	6	29	33	29	34	The average speed of poleward movement of 15 species in relation to warming, estimated by Perry et al. (2005), was 172.3 km/24 yr = 7.2 km/yr or 72 km/decade, not 22 km/decade. The speed of 22 km/decade or 2.2 km/yr was for the 6 species whose boundaries shifted in relation to both climate and time. (Jung, Sukgeun, Jeju National University)
561	6	29	36	29	38	It may also be mentioning here (with regard to possible additional environmental drivers of species distribution changes in the North Sea), that substantial historical oxygen decreases since 1990 have been reported by Queste et al. (2012), Biogeochemistry. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
562	6	29	48	30	8	The figure is ok(fig 6-11) but the panels are arranged in a bit of a confusing format. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
563	6	29	51	29	51	The "orange line" is almost too faint to see on the version of Fig. 6-11 that I have. (Head, Erica, Fisheries and Oceans Canada)
564	6	30	16	0	0	I suggest to incorporate the changes in other macroalgal groups dominant in some North East Atlantic waters like Fucaeans thath shows a very rapid decline in their suothern limit [Lamela, C., Fernández, C., Arrontes, J. y Anadón, R. 2012. Fucoids Assemblages on the North Coast of Spain: Past and Present (1977-2007). Bot.Mar., 55: 199-207 (Anadon, Ricardo, University of Oviedo)
565	6	30	16	30	16	Insert Lima et al., 2007 Lima, F.P., Ribeiro, P.A., Queiroz, N., Hawkins, S.J. & Santos, A.M., 2007. Do distributional shifts of northern and southern species of algae match the warming pattern? Global Change Biology, 13: 2592-2604. (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)

#	Ch	From Page	From Line	To Page	To Line	Comment
566	6	30	19	30	19	NO, NO, NO, NO, there is absolutely no evidence of bleaching at the glacial/interglacial transition, and it could not be, as bbleached corals stop calcification. Add as Chapter 5, p 46, line 20: There is no evidence of mass bleaching in the past, and larger foraminifera show now spectacular shell malformations never seen in the geological past, apart in planktonic ones just after the Cretaceous/Tertiary boundary (Pecheux, 1998, 1999). Pecheux M. 1998, Review on coral reef bleaching. Atoll Res Bull. Edilivre, Paris, printed in 2013, 245 pp. Available from www.reefbase.org or martin-pecheux.fr. Pecheux M, 1999, Weighting up the threat to the world's coral. Nature, 402, 457. (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
567	6	30	19	30	19	If being used as a likelihood term, "likely" should be italicized. Casual usage should be avoided. (Mach, Katharine, IPCC WGII TSU)
568	6	30	24	30	24	Delete "British" replace with "English" (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
569	6	30	28	30	28	General Comment- Worth citing work by Lima et al 2006, 2007a,b. Interesting work showed how one limpet species progressed northwards due to relaxation of upwelling – closing a gap in distribution. Lima, F.P., Queiroz, N., Ribeiro, P.A., Hawkins, S.J., Santos, A.M., 2006. Recent changes in the distribution of a marine gastropod, <i>Patella rustica</i> Linnaeus, 1758, and their relationship to unusual climatic events. Journal of Biogeography, 33, 812-822. Lima, F.P., Ribeiro, P.A., Queiroz, N., Hawkins, S.J. & Santos, A.M., 2007a. Do distributional shifts of northern and southern species of algae match the warming pattern? Global Change Biology, 13: 2592-2604. Lima, F.P., Ribeiro, P.A., Queiroz, N., Xavier, R., Tarroso, P., Hawkins, S.J. & Santos, A.M., 2007b. Modelling past and present geographical distribution of the marine gastropod <i>Patella rustica</i> as a tool for exploring responses to environmental change. Global Change Biology, 13: 2065-2077. (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
570	6	30	29	30	39	There is a much larger body of work on phenological shifts in marine ecosystems than is implied by the two citations here and in Table 6-8. Please perform a literature search and update the references. (UNITED STATES OF AMERICA)
571	6	30	31	30	31	In addition to the summary term for evidence here, the chapter team could consider presenting a summary term for agreement. (Mach, Katharine, IPCC WGII TSU)
572	6	30	42	0	0	This subsection should be expanded to include the implications of sea warming on fish condition (health). Several indicators are available to describe fish condition. Sea temperature has been shown to affect condition of some species, e.g. cod in Greenlandic waters. See e.g. Lloret and Ratz 2000. Fisheries Research 48:79-96; Ratz and Lloret 2003. Fisheries Research 60:369-389, among other examples. In fact I would make a new subchapter stating "fish health" because other indicators of fish health such as parasitism can be influenced by climate change, thus compromising seafood quality and quantity and posing threats to human health. See e.g. Lloret et al. 2012. Reviews in Fisheries Science, 20:3, 165-180 (LLORET, JOSEP, UNIVERSITY OF GIRONA)
573	6	30	44	30	44	In addition to the summary term for evidence here, the chapter team could consider presenting a summary term for agreement. (Mach, Katharine, IPCC WGII TSU)
574	6	30	51	30	51	Insert "Genner et al., 2010" Genner et al 2010 GCB worth citing here – showing interactions with fishing – small fish track climate change – in large fish body size driven by fishing. Genner MJ, Sims DW, Southward AJ, Budd GC, Masterson P, Mchugh M, Rendle P, Southall EJ, Wearmouth VJ, Hawkins SJ. 2010. Body size-dependent responses of a marine fish assemblage to climate change and fishing over a century-long scale. Global Change Biology 16: 517-527. (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
575	6	31	0	31	0	Box-1. Should be removed or integrated within Chapter 30. (Ottersen, Geir, Institute of Marine Research)
576	6	31	3	31	3	The chapter team could consider placing "high confidence" within parentheses at the end of the sentence. (Mach, Katharine, IPCC WGII TSU)

#	Ch	From Page	From Line	To Page	To Line	Comment
577	6	31	3	31	15	There is a lack of appreciation of how microrobial food webs and diversity could be impacted. A paragraph on the fact that whole microbial food webs could shift, with unknown consequences for zooplankton is warranted. Comeau, A. M., W. K. W. Li, J.-É. Tremblay, E. C. Carmack, and C. Lovejoy (2011), Arctic Ocean Microbial Community Structure before and after the 2007 Record Sea Ice Minimum, <i>Plos One</i> . 6(11). e27492. (Lovejoy, Connie, Université Laval)
578	6	31	11	31	11	The chapter team could consider placing "high confidence" within parentheses at the end of the sentence. (Mach, Katharine, IPCC WGII TSU)
579	6	31	15	31	15	add "competitive interactions (Poloczanska et al., 2008)." Poloczanska ES, Hawkins SJ, Southward AJ, Burrows MT. 2008. Modelling the response of populations of competing species to climate change. <i>Ecology</i> 89 (11): 3138-3149. (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
580	6	31	20	31	20	The chapter team could consider placing "very high confidence" within parentheses at the end of the sentence. (Mach, Katharine, IPCC WGII TSU)
581	6	31	22	31	22	Listing of "high confidence" not necessary. (UNITED STATES OF AMERICA)
582	6	31	23	31	26	Suggest to make specific reference to the fact that shallow-water reef-building corals and their reefs are among the marine ecosystems most affected by climate change and in the Executive Summary (Page 4; Line 3). This is a robust result of which we are highly confident since it is based on understanding from both field data and experimental results. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
583	6	31	25	31	25	...reefs are the Earth ecosystem most affected by climate change (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
584	6	31	31	32	51	Box 6.1 Much redundancy with Chapter 30 (Sundby, Svein, Institute of Marine Research)
585	6	31	31	32	51	This section (box) is a bit dense, could it be pruned back? It also flips back and forth between plankton and fish and should be restructured. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
586	6	31	40	31	41	Term NAO is already defined on Page 11, line 27 so might not need to be redefined in this sentence. (Ambulkar, Archis, Brinjac Engineering Inc.)
587	6	31	45	0	0	This paper's conclusions should be interpreted carefully. The conclusion is very regionally biased. Dinoflagellates have no problem with warmer temperatures. (Lovejoy, Connie, Université Laval)
588	6	31	45	31	47	We have been mis-quoted here. Please change the sentence that starts "In the Northwest Atlantic" to "In the Northwest Atlantic plankton distributions are influenced by changes in the prevailing flow from the north, which in shelf regions has included greater contributions of Arctic water and plankton since the 1990s (Head and Pepin 2010)." (Head, Erica, Fisheries and Oceans Canada)
589	6	31	49	31	54	The importance of the distinction between diatoms and dinoflagellates could be better explained. (AUSTRALIA)
590	6	32	1	32	2	Please add to the sentence that currently ends "phytoplankton biomass in the eastern and western temperate North Atlantic from -0.6 to 22°C." thus "phytoplankton biomass in the eastern and western temperate North Atlantic from -0.6 to 22°C, although more recently, based on data from polar, sub-polar and tropical regions, Marañón et al. (2012) have suggested that nutrient availability may actually have a greater influence than temperature on cell size." Reference: Marañón, E., Cermeño, P., Latasa, M. Tadolnéké, R.D. (2012) Temperature, resources, and phytoplankton size structure in the ocean. <i>Limnol. Oceanogr.</i> 57(5), 1266-1278 (Head, Erica, Fisheries and Oceans Canada)
591	6	32	4	32	4	Listing of "low confidence" not necessary. (UNITED STATES OF AMERICA)
592	6	32	10	32	10	Replace "Surpassing" with "Above the CTB there were pronounced etc" (Head, Erica, Fisheries and Oceans Canada)

#	Ch	From Page	From Line	To Page	To Line	Comment
593	6	32	10	32	10	It is a bit strong to say "led to" in this context, please replace with "coincided with". (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
594	6	32	27	32	27	In the English Channel we are aware of shifts in cold water herring to warm water Pilchards (also known as Sardines) back to the Middle Ages (Southward et al., 1988; Hawkins et al., 2003; Southward et al., 1995, 2005) quite small changes in climate triggered these shifts. Pelagic species seem particularly susceptible to such changes. Southward AJ, Boalch GT, Maddock L. 1988. Fluctuations in the Herring and Pilchard fisheries of Devon and Cornwall linked to change in climate since the 16th century. Journal of the Marine Biological Association of the United Kingdom 68 (3): 423-445. Southward AJ, Hawkins SJ, Burrows MT. 1995. Seventy years' observations of changes in distribution and abundance of zooplankton and intertidal organisms in the western English Channel in relation to rising sea temperature. Journal of Thermal Biology 20 (1-2): 127-155. Southward AJ, Langmead O, Hardman-Mountford NJ, Aiken J, Boalch GT, Dando PR, Genner MJ, Joint I, Kendall M, Halliday NC, et al. 2005. Long-term oceanographic and ecological research in the Western English Channel. Advances in Marine Biology 47: 1-105. Hawkins SJ, Southward AJ, Genner MJ. 2003. Detection of environmental change in a marine ecosystem – evidence from the western English Channel. Science of the Total Environment 310: 245-246. (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
595	6	32	33	0	0	(Box 6-1). I suggest adding "and Atlantic mackerel (Jansen et al., 2012)" at the end of the sentence: "... with winter warming being effective for Atlantic cod...". Reference: Jansen, T., Campbell, A., Kelly, C. J., Hátún, H., & Payne, M. (2012). Temperature, Migration and Fisheries of North East Atlantic Mackerel (Scomber scombrus) in Autumn and Winter. PLoS One, 7 (12). (Jansen, Teunis, Danish Technical University - National Institute of Aquatic Resources)
596	6	32	33	32	33	Replace "being effective" with "having the greatest effect" (Head, Erica, Fisheries and Oceans Canada)
597	6	32	40	32	51	I think this paragraph could be dropped. At the moment it flips back a forth between plankton and fish (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
598	6	32	43	32	44	Change the sentence that begins "At the same time" to "At the same time Arctic copepod species became more abundant in shelf and slope regions, due to increased influx of Arctic water (Head and Pepin, 2010)." (Head, Erica, Fisheries and Oceans Canada)
599	6	32	45	32	45	Casual usage of "likely" should be avoided. (Mach, Katharine, IPCC WGII TSU)
600	6	33	2	33	2	Clearly define OMZs. (UNITED STATES OF AMERICA)
601	6	33	4	33	6	Will this transition occur everywhere or only in certain regions? (UNITED STATES OF AMERICA)
602	6	33	28	33	33	This paragraph mixes what has happened with what might happened - it is critical to clarify the difference. (UNITED STATES OF AMERICA)
603	6	34	5	34	5	The chapter team could consider placing "medium confidence" within parentheses at the end of the sentence. (Mach, Katharine, IPCC WGII TSU)
604	6	34	7	34	7	The chapter team could consider placing "high confidence" within parentheses at the end of the sentence. (Mach, Katharine, IPCC WGII TSU)
605	6	34	9	34	10	This sentence says higher marine organisms will disappear with high confidence. This is a strong statement and needs some spatial scale and a bit more context. (UNITED STATES OF AMERICA)
606	6	34	9	34	10	It would be helpful to provide a bit more indication of when, where, and for what scenarios of climate change these sequential changes would occur. (Mach, Katharine, IPCC WGII TSU)
607	6	34	15	0	0	Ocean Acidification (OA) is already defined on Page 7, line 21, so need not to be defined again in the sentence. (Ambulkar, Archis, Brinjac Engineering Inc.)
608	6	34	15	34	15	(hour) not (h) (Pechoux, Martin, Institut des Foraminifères Symbiotiques)

#	Ch	From Page	From Line	To Page	To Line	Comment
609	6	34	15	34	16	Here several months is medium-term whereas earlier (the work of Form and Riebesell performed on deep-sea corals for 6 months) was qualified as long-term. This inconsistent language should be addressed. (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
610	6	34	22	34	33	This is a crucial issue with OA - there are very few (and perhaps none unequivocal) studies observing a population change in the wild attributed to OA. The cases is made largely with lab experiments, the paleo record and natural CO2 seeps. This should be contrasted with evidence for temperature driven climate change effects. What is the difference in data availability vs. time to cross OA thresholds vs. lags in CO2 system? (UNITED STATES OF AMERICA)
611	6	34	22	34	33	This is an incomplete view of the issue because several key papers, including those showing no long-term change in the abundance of calcified plankton are not considered. Mackas D. L. & Galbraith M. D., 2012. Pteropod time-series from the NE Pacific. <i>Ices Journal of Marine Science</i> 69:448-459. Beaugrand G., McQuatters-Gollop A. E., M & Goberville E., in press. Long-term responses of North Atlantic calcifying plankton to climate change. <i>Nature Climate Change</i> Ohman M. D., Lavaniegos B. E. & Townsend A. W., 2009. Multi-decadal variations in calcareous holozooplankton in the California Current System: thecosome pteropods, heteropods, and foraminifera. <i>Geophysical Research Letters</i> 36, L18608. doi:10.1029/2009GL039901. (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
612	6	34	28	34	29	It would be helpful to clarify what is meant by "still early in the process"--ocean acidification has been documented, but it is small compared to natural variability in many areas?? (Mach, Katharine, IPCC WGII TSU)
613	6	34	29	0	0	not sure that contributions of OA to climate-induced changes have not been clearly established because OA is still "early in the process" - not even sure what this means -- but more likely because the OA research is a relatively new field - some may THINK it has a much smaller effect than other drivers (need references for this) but perhaps this is because much less is known about it and the impacts are just now being assessed. (McLeod, Elizabeth, The Nature Conservancy)
614	6	34	37	0	0	You should perhaps explain why. (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
615	6	34	46	34	46	Replace "reaction" with "response" (Head, Erica, Fisheries and Oceans Canada)
616	6	34	53	34	53	Replace "Such a decrease", by: " A decrease of 0.1 in pH" corresponds to... (UNITED STATES OF AMERICA)
617	6	34	53	34	54	as already happened (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
618	6	35	6	0	0	The publication date of Joint et al. is 2011 (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
619	6	35	6	0	0	This sentence does not adequately represent the opinion of Joint et al. (2011) who claimed that "Therefore, an appropriate null hypothesis may be, until evidence is obtained to the contrary, that major biogeochemical processes in the oceans other than calcification will not be fundamentally different under future higher CO2/lower pH conditions." Previous studies (Liu et al., 2010) and other papers published since and cited in this paragraph demonstrate the opposite. (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
620	6	35	8	0	0	Liu et al. (2010) did not propose that "that the rates of several microbial processes will be affected by OA, some positively, others negatively." Liu et al. (2010) performed a metaanalysis which concluded that the rates of several microbial processes will be affected by OA, some positively, others negatively." (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
621	6	35	16	35	16	The chapter team could consider placing "high confidence" within parentheses at the end of this part of the sentence. (Mach, Katharine, IPCC WGII TSU)
622	6	35	21	35	21	The chapter team could consider facing "medium confidence" within parentheses at the end of the sentence. (Mach, Katharine, IPCC WGII TSU)
623	6	35	27	35	27	Replace "parts" with "part" (Head, Erica, Fisheries and Oceans Canada)
624	6	36	10	0	0	Add comma as "For cold-water corals, experimental..." (Ambulkar, Archis, Brinjac Engineering Inc.)

#	Ch	From Page	From Line	To Page	To Line	Comment
625	6	36	10	36	11	Considering recent papers, I think that this could be rephrased as "For cold-water corals, experimental and observational findings suggest significant resilience to OA (medium confidence, 6.2.5)." (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
626	6	36	11	36	11	"The reduction of salinity associated with freshwater input results in lower alkalinity, exacerbates OA": dilution also decreases the pCO ₂ and increases the pH such that it depends on how acidification is defined. A more thorough discussion of the relationship between freshening, CO ₂ and pH is warranted. (UNITED STATES OF AMERICA)
627	6	36	21	36	21	This is very nice concise statement, which I suggest to be included in the Executive Summary: Page 4; Line 4. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
628	6	36	21	36	21	This statement could potentially be clarified compared to the chapter 19 finding on the effects of mitigation for ocean acidification--the chapter 19 finding asserts a most immediate amelioration of ocean acidification following mitigation actions. (Mach, Katharine, IPCC WGII TSU)
629	6	36	21	36	34	The chapter team should consider placing all levels of confidence used in this paragraph within parentheses at the end of the relevant sentences. (Mach, Katharine, IPCC WGII TSU)
630	6	36	21	36	35	Note that a previous attempt at providing an expert judgment on the effects of ocean acidification, which contrasts with the assessment given in the present chapter, is not cited (Gattuso J.-P., Bijma J., Gehlen M., Riebesell U. & Turley C., 2011. Knowns, unknowns and perspectives. In: Gattuso J.-P. & Hansson L. (Eds.), Ocean acidification, pp. 291-312. Oxford: Oxford University Press.) For example, this paper gives a medium level of evidence and a high level of confidence that "Ocean acidification will stimulate primary production". Another example is that, in a recent survey of ocean acidification experts, about 60% of respondents who reported good or expert knowledge assigned a high probability to the veracity of the statement: "anthropogenic ocean acidification will stimulate primary production in some primary producers." It should be pointed out that a number of respondents indicated the importance of the word "some" for their evaluation of the statement (Gattuso J.-P., Mach K. J. & Morgan G., in press. Ocean acidification and its impacts: an expert survey. Climatic Change). These two previous assessments should perhaps be used as additional evidence in this chapter and inconsistencies identified and explained. Otherwise, the message to policy-makers would be blurred. (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
631	6	36	22	0	0	the severity of the effects depends on the scenario followed but ALSO on the ecosystem/species response (McLeod, Elizabeth, The Nature Conservancy)
632	6	36	38	0	0	The impact of river runoff (affected by climate change) on exploited fish production could be better explained as there are many examples world-wide. See e.g. Lloret et al. 2001. Fisheries Oceanography 10(1):33-50 (LLORET, JOSEP, UNIVERSITY OF GIRONA)
633	6	36	44	36	45	Replace "Casini et al., 2009), however, they may" with "Casini et al., 2009), although they may" (Head, Erica, Fisheries and Oceans Canada)
634	6	36	45	36	45	"....and change (e.g Genner et al., 2010)." Genner MJ, Sims DW, Southward AJ, Budd GC, Masterson P, Mchugh M, Rendle P, Southall EJ, Wearmouth VJ, Hawkins SJ. 2010. Body size-dependent responses of a marine fish assemblage to climate change and fishing over a century-long scale. Global Change Biology 16: 517-527. (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
635	6	36	47	0	0	Need to change "-", not sure if they are needed i.e. "concentrations - (xxxx) - or..." (Ambulkar, Archis, Brinjac Engineering Inc.)
636	6	37	4	37	4	comparable paleo-events - such as? (Stouffer, Ronald, Geophysical Fluid Dynamics Laboratory/NOAA)
637	6	37	4	37	4	...more than 10-100 faster than during the Paleocene-Eocene Thermal Maximum but probably not as fast as during the asteroidal Cretaceous/Tertiary event (Pecheux, Martin, Institut des Foraminifères Symbiotiques)

#	Ch	From Page	From Line	To Page	To Line	Comment
638	6	37	4	37	9	Expand discussion of PETM age and duration, including astronomical tuning and radiometric dating (PETM is not exactly 55 Ma), as it is essential in the context of modern OA discussed here (UNITED STATES OF AMERICA)
639	6	37	6	37	6	Move a comma thus "Schmidt, 2010) when, similar to today, OA etc" (Head, Erica, Fisheries and Oceans Canada)
640	6	37	10	37	10	Replace "however," with "although" - noting the omission of the comma (Head, Erica, Fisheries and Oceans Canada)
641	6	37	10	37	12	. The Cretaceous/Tertiary (65 Ma) and the Permian Triassic (251 Ma)... (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
642	6	37	21	37	21	Still question marks in the text. (NETHERLANDS)
643	6	38	1	38	1	Change to "cause shrinkage of biogeographical ranges (Figure 6-7)" - noting the omission of the comma. (Head, Erica, Fisheries and Oceans Canada)
644	6	38	6	38	9	Say which species are studied by the references (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
645	6	38	9	38	10	Term OCLTT is defined in this sentence, however, it first appeared on page 15, line 25 and should be defined there instead. (Ambulkar, Archis, Brinjac Engineering Inc.)
646	6	38	13	38	20	This section of the chapter would be easier to read if definitions of species, populations, communities, biota and ecosystems were set out. (AUSTRALIA)
647	6	38	22	38	23	Chapter 30 can be cited on that less than 2 % (1.80 to be precise) of the ocean area and 7 % of the world ocean phytoplankton production occur in the four eastern boundary upwelling ecosystems (Sundby, Svein, Institute of Marine Research)
648	6	38	40	0	0	I suggest to incorporate the references: Llope, M., Anadón, R., Viesca, L., Quevedo, M., González-Quirós, R., Stenseth, N.C. 2006 Hydrography of the Southern Bay of Biscay shelf break region: integrating the multi-scale physical variability over the period 1993-2003. J. Geophys. Res. 111, C0921, doi:10.1029/2005JC002963; FIZ F. PÉ REZ, XOSE A . PADÍN, Y. PAZOS, M. GILCOTO, M. CABANAS, P.C. PARDO, M.D.S DOVAL and L. FARIÑA-BUSTO. (2010) Plankton response to weakening of the Iberian coastal upwelling. Global Change Biology 16, 1258–1267, doi: 10.1111/j.1365-2486.2009.02125.x]. These two references shows changes in upwelling events frequency and intensity. Also and in my opinión by relevant for analysing future changes, shows changes in the timing of upwelling, related to changes in wind stress. Both and the Lemos and Sansó were only affected seasonally for upwellings. The changes in the southern and northern limits of upwelling affected zones could be very significant for biogeographical and dynamical aspects of marine ecosystems. (Anadon, Ricardo, University of Oviedo)
649	6	38	48	0	0	I suggest to incorporate the idea of the curl upwelling in the sense of Rykaczewski and Checkley, but also in Pickett, M.H. and Schwing, F.B. 2006 Evaluating upwelling estimates off the west coast of North and South America. Fisheries Oceanogr. 13(3): 256-269. (Anadon, Ricardo, University of Oviedo)
650	6	38	51	38	51	General Comment – relaxation of upwelling can lead to expansion of cold water species; work by Lima et al., 2006 on the limpet P.rustica. relaxation of upwelling enabled expansion in Northern Portugal. Worth a mention? Lima, F.P., Queiroz, N., Ribeiro, P.A., Hawkins, S.J., Santos, A.M., 2006. Recent changes in the distribution of a marine gastropod, Patella rustica Linnaeus, 1758, and their relationship to unusual climatic events. Journal of Biogeography, 33, 812-822. (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
651	6	39	16	39	16	On the Figure 6-13 the box labeled "Phenology shift" should be labeled "Phenological shift" (Head, Erica, Fisheries and Oceans Canada)
652	6	39	20	39	21	Are the "reductions in the body size of organisms" across all tropic levels or just fish? - this is unclear (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)

#	Ch	From Page	From Line	To Page	To Line	Comment
653	6	39	27	0	0	Box CC-OA identifies ocean acidification as an issue distinct to climate change, with the same cause generating both. Hence, this sentence should be revised as "... that climate change and ocean acidification..." (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
654	6	39	27	39	27	The chapter team could consider placing "high confidence" within parentheses at the end of the sentence (or at the start of both parenthetical lists of references). (Mach, Katharine, IPCC WGII TSU)
655	6	39	31	39	32	The sentence that begins "Shifted geographical distribution" is ugly and grammatically incorrect. It should read "Shifts in geographical distributions of marine species (e.g. to higher latitudes or deeper waters) cause changes in community etc" (Head, Erica, Fisheries and Oceans Canada)
656	6	39	32	39	32	Insert "Poloczanka et al., 2008" Poloczanska ES, Hawkins SJ, Southward AJ, Burrows MT. 2008. Modelling the response of populations of competing species to climate change. Ecology 89 (11): 3138-3149. (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
657	6	40	5	0	0	Reef-building rather than tropical (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
658	6	40	11	40	12	The chapter team could consider placing "high confidence" within parentheses at the end of the statement. (Mach, Katharine, IPCC WGII TSU)
659	6	40	20	40	38	Throughout these paragraphs, the chapter team could consider further parenthetical presentation of calibrated uncertainty language. Additionally, on line 36, "limited evidence" should be used in place of "low evidence." (Mach, Katharine, IPCC WGII TSU)
660	6	40	21	40	23	The process of "Phenology" is noted twice within one sentence. I would suggest replacing "development, reproduction, behavior and phenology" with "development, reproduction and behavior". (Head, Erica, Fisheries and Oceans Canada)
661	6	40	26	0	0	Word "body" repeated twice in the sentence, please delete one. (Ambulkar, Archis, Brinjac Engineering Inc.)
662	6	40	36	40	38	The sentence that begins "With low evidence, medium agreement and thus medium confidence" does not seem logical. It seems to be saying that we are pretty sure there will be changes in community composition and species interactions due to trophic amplification, but that we don't have much confidence that trophic amplification will occur." If trophic amplification is NOT the only mechanism, then the sentence should read - "With low evidence, medium agreement and thus medium confidence, community reassembly and ecosystem mixing may lead to new ecosystem states, and in some cases there may be trophic amplification (low confidence)." (Head, Erica, Fisheries and Oceans Canada)
663	6	40	48	0	54	I suggest to incorporate as very important service the maritime transport, and not related with climate but probably related with the noise. (Anadon, Ricardo, University of Oviedo)
664	6	40	49	0	52	what about coastal protection (from coastal habitats such as reefs/mangroves) - this one is critical especially in light of increasing sea level and also changes in storm patterns/intensity (Mcleod, Elizabeth, The Nature Conservancy)
665	6	41	4	41	9	An additional and important source of uncertainty is baseline conditions. To determine the future impact of climate change and ocean acidification it is necessary to know the condition of the resource in their absence. It is possible that over-harvest and other stressors on ocean resources would cause enough damage on their own that the incremental damages from climate change and ocean acidification are relatively small in comparison. (UNITED STATES OF AMERICA)
666	6	41	14	41	15	Up-to-date statistics for Pacific Island coral reef fisheries in Bell et al (2011)Vulnerability of Pacific Fisheries and Aquaculture to Climate Change, SPC, Noumea, New Caledonia, 925pp; (Lough, Janice, Australian Institute of Marine Science)
667	6	41	16	0	0	Should it be "75 and 85 million tonnes per year" (Ambulkar, Archis, Brinjac Engineering Inc.)
668	6	41	21	41	21	The chapter team could consider placing "high confidence" within parentheses at the end of the statement. (Mach, Katharine, IPCC WGII TSU)

#	Ch	From Page	From Line	To Page	To Line	Comment
669	6	41	25	0	0	Change reference from (Sebatés et al., 2006) to (Sebatés et al., 2006; Jansen et al., 2012) (Jansen, Teunis, Danish Technical University - National Institute of Aquatic Resources)
670	6	41	25	41	21	The Cheung et al paper is now published [Aquatic Conservation 22(3): 368-388, 2012] and includes useful narrative on changes in the effectiveness of fishery MPAs that might be included here. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
671	6	41	31	41	32	This sentence appears to imply that, of all the impacts of ocean acidification, it will be invertebrate fisheries and aquaculture that are most vulnerable. That conclusion cannot be drawn from the paper cited. It is likely that invertebrate fisheries and aquaculture will be "very vulnerable" not "most vulnerable". (AUSTRALIA)
672	6	41	32	41	32	Somewhere near here define OA again for the reader. (Stouffer, Ronald, Geophysical Fluid Dynamics Laboratory/NOAA)
673	6	41	32	41	32	Barton does not make claims about all invertebrate fisheries and aquaculture. Please be more specific in this statement. (UNITED STATES OF AMERICA)
674	6	41	38	41	38	Insert "Genner et al., 2010" Genner MJ, Sims DW, Southward AJ, Budd GC, Masterson P, Mchugh M, Rendle P, Southall EJ, Wearmouth VJ, Hawkins SJ. 2010. Body size-dependent responses of a marine fish assemblage to climate change and fishing over a century-long scale. Global Change Biology 16: 517-527. (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
675	6	41	43	0	0	change "effect" to "affect" (McLeod, Elizabeth, The Nature Conservancy)
676	6	41	43	41	43	"effect" should be "affect" (Head, Erica, Fisheries and Oceans Canada)
677	6	41	44	41	46	Are the values of losses and adaptation costs provided here cumulative totals between now and 2050 or "per year" sums for 2050? (Mach, Katharine, IPCC WGII TSU)
678	6	41	44	41	51	There appears to be contrast between the conclusions drawn from the sentence beginning 'economic losses' and the sentence beginning 'globally, the impacts'. Please clarify these sentences. (AUSTRALIA)
679	6	41	54	41	51	It might be useful to include a sentence based on Narita et al (2012) [Climatic Change, 113 (3-4). pp. 1049-1063.] that attempts to provide a global quantification of OA costs. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
680	6	42	2	0	0	This subchapter, in my opinion, is too short in view of the important provisioning services that will be affected by climate change. First, seafood provides several health benefits, including cardio and cancer protective effects, which are attributed to the high intake of seafood-derived n-3 (omega-3) fatty acids. Second, marine organisms, particularly the benthic ones, have furnished a large variety of bioactive metabolites, some of which are being developed into new drugs to treat major human diseases such as cancer. See e.g. Lloret 2010. Human health benefits supplied by Mediterranean marine biodiversity. Marine Poll. Bull. 60(10):1640-1646 http://www.sciencedirect.com/science/article/pii/S0025326X10003401 (LLORET, JOSEP, UNIVERSITY OF GIRONA)
681	6	42	8	42	9	"Climate change etc" should be replaced by "Climate change increases the demand for marine renewable energy such as wind and wave power, although ecosystem impacts of their infrastructure requirements need to be considered (6.4.2)." (Head, Erica, Fisheries and Oceans Canada)
682	6	42	14	42	15	The phrase "newly open previously inhospitable areas as peak seasons shift" is unclear and needs re-writing - I don't know what the authors are trying to say. (Head, Erica, Fisheries and Oceans Canada)
683	6	42	16	42	17	stable levels of atmospheric CO2 level - Stable? BY most measures, glacial-interglacial CO2 levels are not stable. Reword. (Stouffer, Ronald, Geophysical Fluid Dynamics Laboratory/NOAA)
684	6	42	17	42	17	"(between 170 and 276 microatm;" this is a large range and cannot be considered "relatively stable". (UNITED STATES OF AMERICA)
685	6	42	17	42	17	The statement that alternative recreation opportunities "seem short lived and unsustainable" is made without supporting evidence. Either remove or provide support for that statement. (UNITED STATES OF AMERICA)

#	Ch	From Page	From Line	To Page	To Line	Comment
686	6	42	19	42	19	The chapter team could consider placing "high confidence" within parentheses at the end of the statement, or after "key role." (Mach, Katharine, IPCC WGII TSU)
687	6	42	21	42	21	The organic carbon biological pump and the CaCO ₃ counter-pump (Pechoux, Martin, Institut des Foraminifères Symbiotiques)
688	6	42	42	42	44	Given the terminology of the special report on extremes, it would be preferable to use a phrase such as "extreme weather and climate events" rather than "natural hazard." (Mach, Katharine, IPCC WGII TSU)
689	6	42	44	0	53	There are a detailed reference to problems related with temperature and coral reefs in chapter 5. I suggest to coordinate the references related with these coastal problems (Anadon, Ricardo, University of Oviedo)
690	6	42	44	42	45	The wording of this statement should be carefully considered. Not all extreme events are projected to increase (similarly) in frequency and/or intensity. For example, for floods overall changes, much less changes associated with climate change, have not been observed. For some types of floods, changes have been observed, and losses associated with floods have increased due to increases in exposure--but care should be taken such that the statement here does not imply increases in floods due to warming to date. (Mach, Katharine, IPCC WGII TSU)
691	6	42	45	0	0	what is reference "(SREX)? (McLeod, Elizabeth, The Nature Conservancy)
692	6	42	45	0	0	suggest changing "natural ocean structures and organisms" to "coastal and marine habitats" or "coastal and marine ecosystems" (McLeod, Elizabeth, The Nature Conservancy)
693	6	42	45	0	0	Term SREX needs to be defined in this sentence i.e. its long form. (Ambulkar, Archis, Brinjac Engineering Inc.)
694	6	42	45	42	45	Please define SREX. (UNITED STATES OF AMERICA)
695	6	42	45	42	46	The statement that "the role of ocean structures and organisms in reducing the effects of natural hazards has been undervalued" needs a citation. The citations that follow provide evidence of their value but not necessarily that they are undervalued. (UNITED STATES OF AMERICA)
696	6	42	45	42	47	The role of coral reefs in providing coastal protection is important and policy relevant. I suggest to also include mention of Sheppard et al. (2005) here for consistency with Box CC-CR, but also to highlight in the body of the text that coral mortality and loss of fringing reefs has been linked with increases in wave energy and coastal erosion. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
697	6	42	49	42	49	It would be preferable to specify the relevant specific sections of chapter 5 here, as well as on line 52. (Mach, Katharine, IPCC WGII TSU)
698	6	43	14	43	17	What about the negative impacts on ecotourism, e.g. at sites that lose seabirds or marine mammals? (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)

#	Ch	From Page	From Line	To Page	To Line	Comment
699	6	44	0	0	0	Section 6.4.2.1. General Comment: is it worth commenting on impacts of adaptational responses such as sea defences in the face of rising and stormier seas. These may have more impact than climate change alone. In the face of increasingly defended coastlines, then such defences should be designed in an environmentally sensitive manner (See Airolidi et al., 2005, Martins et al., 2005; Moschella et al., 2005; Firth et al., 2013 (in press) Airolidi L, Abbiati M, Beck MW, Hawkins SJ, Jonsson PR, Martin D, Moschella PS, Sundelof A, Thompson RC, Aberg P. 2005. An ecological perspective on the deployment and design of low-crested and other hard coastal defence structures. Coastal Engineering 52: 1073-1087. Martin D, Bertasi F, Colangelo MA, Vries M, Frost M, Hawkins SJ, Macpherson E, Moschella P, Satta MP, Thompson RC, Ceccherelli VU. 2005. Ecological impacts of coastal defence structures on sediment and mobile fauna: Evaluating and forecasting consequences of unavoidable modifications of native habitats. Coastal Engineering 52: 1027-1051. Moschella PS, Abbiati M, Åberg P, Airolidi L, Anderson JM, Bacchiocchi F, Bulleri F, Dinesen GE, Frost M, Gacia E, et al. 2005. Low-crested coastal defence structures as artificial habitats for marine life: using ecological criteria in design. Coastal Engineering 52: 1053-1071. Firth, L. B., Thompson, R. C., White, F. J., Schofield, M., Skov, M. W., Hoggart, S. P. G., Jackson, J., Knights, A. M., Hawkins, S. J. (2013), The importance of water-retaining features for biodiversity on artificial intertidal coastal defence structures. Diversity and Distributions. doi: 10.1111/ddi.12079 (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
700	6	44	3	44	3	This should be "Human societies benefit from and depend on marine ecosystem services" (Head, Erica, Fisheries and Oceans Canada)
701	6	44	7	44	30	For the calibrated uncertainty language on these lines, the chapter team should consider further parenthetical presentation of the terms to maximize directness and clarity of the statements made. (Mach, Katharine, IPCC WGII TSU)
702	6	44	9	0	0	"affects" (Somero , George , Stanford University)
703	6	44	11	0	12	The above mention of noise and the maritime transport and the interaction with climate change could be properly addressed in this paragraph. (Anadon, Ricardo, University of Oviedo)
704	6	44	14	44	15	Should read "although projections of such impacts into the future have low confidence, partly because of the low confidence in predicting climate change effects on marine primary production (6.5)." (Head, Erica, Fisheries and Oceans Canada)
705	6	44	15	44	19	The conclusion (6.4.1.7) that (1) geological and present data demonstrate "high agreement and confidence" that marine ecosystems regulate climate and (2) that there is "high confidence" that the effect of climate change on biota will alter the magnitude of these processes should be included in the Executive Summary (this point is also made in Sect 6.6.1). (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
706	6	44	17	44	18	the balance between photosynthesis, respiration and calcification (NB: Calcification is the Earth regulatory system at thousand to billion years scale) (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
707	6	44	44	0	0	what does "increased variability of ecosystems" refer to? Variability of ecosystem response to climate change? Need to clarify this. (Mcleod, Elizabeth, The Nature Conservancy)
708	6	45	2	0	0	section on "geoengineering approaches" - suggest including reference: Rau, G.H., E. Mcleod, and O. Hoegh-Guldberg. 2012. Ocean Conservation in a High CO2 World: The Need to Evaluate New Approaches. Nature Climate Change 2: 720-724. --- important to note in this section that "although geoengineering options might only prove practical and effective at local or regional scales, little research has been done to determine the true nature and range of possible strategies and their potential scale and effectiveness. Local-scale mitigation is particularly relevant for many tropical coastal communities who depend directly on marine resources for their food, livelihoods and well-being. In lieu of dealing with the core causal factor (i.e., increasing emissions of greenhouse gases), these techniques and approaches could ultimately represent 'opportunities of last resort'." (Mcleod, Elizabeth, The Nature Conservancy)

#	Ch	From Page	From Line	To Page	To Line	Comment
709	6	45	2	0	36	A leaflet recently published by Cefas summarises the wide range of known marine geoengineering techniques including many not mentioned in this section or in Table 6-10 on page 752. It can be found at: http://www.cefas.defra.gov.uk/publications/files/20120213-Brief-Summary-Marine-Geoeng-Techs.pdf (Vivian, Chris, IMAREST)
710	6	45	2	45	36	Section 6.4.4.2: Refer to and build on relevant sections in Ch6 and 7 of the WGI AR5, including the technical box on Geoengineering in Ch7, rather than reassessing from scratch the physical science basis of proposed CDR and SRM methods. (Plattner, Gian-Kasper, IPCC WGI TSU)
711	6	45	6	0	0	Term SRM is already defined on Page 5, line 38. (Ambulkar, Archis, Brinjac Engineering Inc.)
712	6	45	6	45	6	I think "Reduction" should be replaced by "Removal" (Head, Erica, Fisheries and Oceans Canada)
713	6	45	6	45	6	CDR: Is general referred as Carbon Dioxide Removal (in geoengineering terms). (NETHERLANDS)
714	6	45	7	0	0	"CDR removes atmospheric CO2 by directly sequestering it into the ocean". This statement is incorrect: it needs to be changed to "Proposed CDR techniques include both ocean- and land-based approaches, the former including storage beneath the seafloor". (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
715	6	45	7	45	8	Wording implies that CDR technologies are already at hand. Please consider the large uncertainties attached to CDR and reformulate, e.g.: "C D R i s e x p e c t e d t o r e m o v e a t m o s p h e r i c C O 2 b y d i r e c t l y ...". (GERMANY)
716	6	45	8	45	8	From chemical viewpoint injection of "sulphur" is nonsense. Sulphur is a chemical element. Injection can be done in the form of sulphur-containing gases (H2S or SO2) which are precursors of stratospheric sulfate aerosol. It would be better to say "...via stratospheric injection of sulfate aerosol." (Ryaboshapko, Alexey, Institute of Global Climate and Ecology)
717	6	45	9	45	9	It would be more logical to give another reference instead of [Crutzen, 2006]. It is [Budyko M.I., 1982. The Earth Climate: Past and Future. New York: Academic Press, 307 p.]. (Ryaboshapko, Alexey, Institute of Global Climate and Ecology)
718	6	45	10	0	0	"The use of SRM... CO2 release and OA are left unabated". This statement is incorrect. If SRM were to be used to prevent future temperature increase, then (assuming its effectiveness in that regard), then temperature-driven feedbacks causing additional terrestrial CO2 releases (from enhanced decomposition, increased fires etc) would not occur. Thus there would be some abatement both of CO2 releases and OA. For discussion of these effects, see Williamson & Turley (2012) - that reference is already given on p 61, line 33 (in context of Box cc-OA). (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
719	6	45	10	0	11	DELETE: "...unless SRM is combined with CO2 emission reductions or CO2 removal." Given the uncertainties associated with both SRM and CDR, this qualifying phrase is too speculative to be meaningful/useful. (Mooney, Pat Roy, Action Group on Erosion, Technology and Concentration (ETC Group))
720	6	45	10	45	10	"OA are left unabated..." See the comment to (Chapter 5, Page 50, Lines 26-28) (Ryaboshapko, Alexey, Institute of Global Climate and Ecology)
721	6	45	11	45	12	It is truth that "sudden cessation of SRM would effect on ecosystems". However, naïve questions arise - why the implementation should be stopped suddenly? Why the cessation cannot be gradual? (Ryaboshapko, Alexey, Institute of Global Climate and Ecology)
722	6	45	11	45	12	Are there more studies (in addition to the Russell et al [2012] review) which address the implications of SRM termination, particularly with a focus on ecosystems? If possible, this high impact statement should be expanded and included in the executive summary (Page 5; Line 38). (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)

#	Ch	From Page	From Line	To Page	To Line	Comment
723	6	45	14	45	16	Table 6-10: Sequestration of organic carbon: Storage of crop residue or wood biomass...Physical impact...H ₂ S, as river inputs. Add ref: Keil RG, Nuwer JM, Strand SE, 2010, Burial of agriculture byproducts in the deep sea as a form of carbon sequestration: a preliminary experiment. Marine Chemistry, 122, 91-95. (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
724	6	45	18	0	0	DIC term is not defined or elaborated in this chapter prior to being used in this sentence. Actually it is defined at page 129, Table 6-6. So, please revise accordingly. (Ambulkar, Archis, Brinjac Engineering Inc.)
725	6	45	19	45	19	(Table 6-10; IPCC 2005; Williamson... (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
726	6	45	21	0	0	Term HNLC is already defined on Page 28, line 37 so might not need to be redefined in this sentence. (Ambulkar, Archis, Brinjac Engineering Inc.)
727	6	45	33	0	36	This sentence 's conclusion that CO ₂ lakes on the seabed appear less harmful on larger scales than the impacts caused by ocean fertilization may well be true but it appears to be an opinion rather than be supported by evidence. (Vivian, Chris, IMAREST)
728	6	45	36	45	36	However, part of the CO ₂ would return to the atmosphere after deep sea turnover of thousand years time scale. The safest is deep sea drowning of wood, which would be not harmful, but at a very small risk of methanisation. Charcoal instead is totally inert, but in this case it can be stocked on land. (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
729	6	45	42	45	42	HABs are mostly "natural phenomena" NOT "a natural phenomenon" (Head, Erica, Fisheries and Oceans Canada)
730	6	45	46	45	46	...species-specific responses (Moore et al., 2007, Fu et al., 2012),.... Fu FX, Tatters AO, Huchins DA, 2012, Global change and the future of harmful algae blooms in the ocean. Mar Ecol Prog Ser, 470, 207-233. Moore SK, Trainer VL, Nantua NJ, Parker MS, Laws EA, Backer LC, Fleming LE, 2007, Impacts of climate variability and future climate change on harmful algal blooms and human health. Environ Health, 7, S4, 1-12. (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
731	6	45	49	0	0	Should be "HABs" instead of "HABS" (Ambulkar, Archis, Brinjac Engineering Inc.)
732	6	45	49	45	49	Add: ...Dave et al 2006). Although there are indication that harmful algae are "CO ₂ -lovers" (Siegelman and McKenzie, 1979, Blackburn and Oshima, 1989, Yoo, 1991, Hinga, 1992, Berman-Frank et al., 1997, Rost et al., 2003, Dason et al., 2004, Fu et al., 2008), it has not yet been proposed that the increase of their bloom frequency, intensity and magnitude (van Dolah, 2000, Gilbert et al., 2005) is due to OA. Berman-Frank I, Erez J, Kaplan A, 1997, Change in inorganic uptake during progression of a dinoflagellate bloom in a lake ecosystem. Can J Bot, 76, 1043-1051. Blackburn SI, Oshima Y, 1989, Review of culture methods for Pyrodinium bahamense. In: Hallegraeff GM, MacClean JL (eds), Biology, epidemiology and management of Pyrodinium red tides. Fisheries Dept., Ministry of Development, Manila, 227-233. Dason JS, Huertas EI, Colman B, 2004, Source of inorganic carbon for photosynthesis in two marine dinoflagellates. J Phycol, 40, 285-292. Gilbert PM, Anderson DM, Gentien P, Sellner KG, 2005, The global complex phenomena of harmful algae. Oceanography, 18, 136-147. Hinga KR, 1992, Co-occurrence of dinoflagellate blooms and high pH in marine enclosure. Mar Ecol Prog Ser, 86, 181-186. Hollander DJ, McKenzie JA, 1991, CO ₂ control on carbon-isotope fractionation during aqueous photosynthesis: a paleoCO ₂ barometer. Geology, 19, 929-932. Rost B, Riebesell U, Burkhart S, Sultmeier D, 2003, Carbon acquisition of bloom-forming marine phytoplankton. Limnol Oceanogr, 12, 55-67. Siegelman H, Levandowski M, 1979, Culturing of dinoflagellates. In: Taylor DL, Seliger HH, Toxic dinoflagellate blooms. Development in Marine Biology, Vol 1, 471-472. van Dolah FM, 2000, Marine algal toxins: origins, health effects, and their increasing occurrence. Environ Health Perspect, 108, 133-141. Yoo KL, 1991, Population of dinoflagellate community in Masan Bay with a note on the impact of the environmental parameters. Mar poll Bull, 23, 185-188. (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
733	6	46	2	46	3	Include Baker-Austin et al 2013 (already in the reference list) among the studies listed. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)

#	Ch	From Page	From Line	To Page	To Line	Comment
734	6	46	9	46	9	"18-year climate record" There needs to be some discussion of how many years of data constitutes a "climate record". This seems like a very short time period to establish a climate record. (UNITED STATES OF AMERICA)
735	6	46	11	0	0	Term ENSO is already defined in the chapter. (Ambulkar, Archis, Brinjac Engineering Inc.)
736	6	46	16	46	16	Observational records from a reanalysis of Continuous Plankton Recorder samples suggest that Vibrios have become increasingly prevalent in the North Sea over the past 50 years (Vezulli et al 2011; The ISME Journal (2012) 6, 21–30) (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
737	6	46	16	46	16	The chapter team could consider presenting a summary term for agreement here as well. (Mach, Katharine, IPCC WGII TSU)
738	6	46	29	46	29	The chapter team could consider presenting "high confidence" within parentheses at the end of the statement. (Mach, Katharine, IPCC WGII TSU)
739	6	46	36	46	36	The chapter team could consider presenting a summary term for agreement here as well. (Mach, Katharine, IPCC WGII TSU)
740	6	46	46	0	0	suggest adding reference: Mcleod et al. 2012 so it reads: "Barange et al., 2010; Stock et al., 2011; Mcleod et al. 2012) Mcleod, E., A. Green, E. Game, K. Anthony, J. Cinner, S.F. Heron, J. Kleypas, C.E. Lovelock, J.M. Pandolfi, R.L. Pressey, R. Salm, S. Schill, and C. Woodroffe. 2012. Integrating climate and ocean change vulnerability into conservation planning. Coastal Management 40: 651-672. (Mcleod, Elizabeth. The Nature Conservancy)
741	6	46	46	46	46	Insert "Poloczanska et al., 2008" Poloczanska ES, Hawkins SJ, Southward AJ, Burrows MT. 2008. Modelling the response of populations of competing species to climate change. Ecology 89 (11): 3138-3149. (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
742	6	46	53	46	53	Please provide a specific referent to WGI. (Plattner, Gian-Kasper, IPCC WGI TSU)
743	6	47	5	0	0	Projections of NPP are provided by Bopp L., Resplandy L., Orr J. C., Doney S. C., Dunne J. P., Gehlen M., Halloran P., Heinze C., Ilyina T., Séférian R., Tjiputra J. & Vichi M., 2013. Multiple stressors of ocean ecosystems in the 21st century: projections with CMIP5 models. Biogeosciences Discussions 10:3627-3676. (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
744	6	47	5	47	5	The seasonal amplitude and timing of peak ocean primary production is also projected to change in response to climate change. Pending acceptance, I suggest inclusion of Henson et al. (2013) [doi:10.5194/bgd-10-1421-2013] who use CMIP5 ESMs to investigate this issue. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
745	6	47	7	0	9	In my opinion the timing of primary production blooms could be as relevant as amount of primary production. There are few data on respect to these interesting topic but in a paper submitted to Global change Biology we show temporal changes that problably affect to the whole pelagic community. I suuggest to introduce a short paragraph in these sense. (Anadon, Ricardo, University of Oviedo)
746	6	47	15	0	0	I suggest to change the position of the (figure6-14) after the reference of Steinacher et al in the line 11 (Anadon, Ricardo, University of Oviedo)
747	6	47	15	47	23	In the discussion of increases and decreases in NPP, there is inconsistency in the sign convention for percentage values. Some statements use negative numbers to indicate reductions, others do not. Suggest modifying text so sign conventions are consistent. (UNITED STATES OF AMERICA)
748	6	47	18	47	19	Put in the riht order, from 2.6 to 8.5. And 2100, not 2990s. (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
749	6	47	35	47	39	Fig 6-14. Gives names and references of the four models. (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
750	6	47	42	47	42	This section needs confidence limits on these statements. (UNITED STATES OF AMERICA)

#	Ch	From Page	From Line	To Page	To Line	Comment
751	6	47	42	48	37	In basic, decrease in primary production connects to the decrease of fish production. But in some case it does not occur. For example, Okunishi et al. (2012) projected the compensation of food limitation by the farther north migration by Japanese sardine. Moreover, Ito et al. (2010) and Ito et al. (accepted) projected increase of egg production because of migration route change which is triggered by the food limitation. So, fish response is much more complex. This kind of issue must be denoted. Okunishi T., S. Ito, T. Hashioka, T. T. Sakamoto, N. Yoshie, H. Sumata, Y. Yara, N. Okada, Y. Yamanaka, 2012, Impacts of climate change on growth, migration and recruitment success of Japanese sardine (<i>Sardinops melanostictus</i>) in the western North Pacific, Climatic Change, 3-4, 485-503, DOI 10.1007/s10584-012-0484-7. Ito S., K. A. Rose, A. J. Miller, K. Drinkwater, K. M. Brander, J. E. Overland, S. Sundby, E. Curchitser, J. W. Hurrell and Y. Yamanaka, 2010, Ocean ecosystem responses to future global change scenarios: A way forward, In: M. Barange, J.G. Field, R.H. Harris, E. Hofmann, R. I. Perry, F. Werner (Eds) Global Change and Marine Ecosystems. Oxford University Press., 287-322, pp440. Ito S., T. Okunishi, M.J., Kishi, M. Wang, 2013, Modeling ecological responses of Pacific saury (<i>Cololabis saira</i>) to future climate change and its uncertainty, accepted to ICES Journal of Marine Science. (Ito, Shin-ichi, Fisheries Research Agency, Tohoku National Fisheries Research Institute)
752	6	47	49	47	50	Please check this statement, it seems incorrect. "Some species are expected to shift toward the equator following the regional temperature gradient". Is this supposed to be shift 'poleward'? If it is correct as written, it is out of place and lacking context to contrast with the previous and following sentences. (UNITED STATES OF AMERICA)
753	6	48	7	48	7	Caption to figure 6-15 not clearly explained and hence is very confusing. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
754	6	48	8	48	16	Fig 6-15 B Shift in latitudinal centroid 23 km not 23 m. (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
755	6	48	8	48	16	Fig. 6-15. Median = 23 km/decade. (Jung, Sukgeun, Jeju National University)
756	6	48	19	48	19	It would be preferable to specify the "main assumptions" mentioned, given the visibility of the corresponding findings. (Mach, Katharine, IPCC WGII TSU)
757	6	48	20	48	20	under RCP2.5 as well There is already a long-term decline. (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
758	6	48	20	48	20	RCP 3 should be 2.6. (Mach, Katharine, IPCC WGII TSU)
759	6	48	23	48	23to be most threatened, if still exist,... (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
760	6	48	28	48	37	There are good examples of using similar bioclimate envelope models to provide projections for seabirds (Huntley et al. 2007, Climatic Atlas of European Breeding Birds) and for benthic invertebrates (Reiss et al. MEPS Vol. 442: 71–86, 2011) (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
761	6	48	42	49	15	Do any of the studies to project future climate impacts on fisheries consider changes in bycatch? (UNITED STATES OF AMERICA)
762	6	48	44	48	44	Here it would be preferable to specify the relevant subsections of chapter 7. (Mach, Katharine, IPCC WGII TSU)
763	6	48	54	0	0	here again there is an assumed increase in fish stocks with warming whereas the best information available from the southeastern Bering Sea is that there will be a major decrease in walleye pollock (Hunt, George, University of Washington)
764	6	49	1	49	3	Chapter 5 p27 lines 34-35 imply that the Indian Ocean may benefit from warming, which seems inconsistent with what is written here. It is not clear what the word "This" at the beginning of the sentence is referring to - it appears to refer to the content of the previous sentence and not to the Allison reference at the end of the sentence. (Brander, Keith, Technical University of Denmark)
765	6	49	19	49	19	It should read "Mollusc fisheries and aquaculture are projected to be....." (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)

#	Ch	From Page	From Line	To Page	To Line	Comment
766	6	49	35	49	39	These statements could be further qualified. Presumably the chapter team is referring in particular to rudimentary understanding in the context of making specific quantitative projections. Based on the other findings of the chapter, it seems more general qualitative conclusions can be made. Further specificity regarding what is meant here would be helpful. (Mach, Katharine, IPCC WGII TSU)
767	6	49	47	49	50	The distinction between the 2 parts of the sentence could be clarified. Additionally, further parenthetical presentation of calibrated uncertainty language could be considered. (Mach, Katharine, IPCC WGII TSU)
768	6	49	52	49	54	The chapter team could consider presenting "high confidence" within parentheses for the statements. (Mach, Katharine, IPCC WGII TSU)
769	6	49	53	49	53	Will there be no changes in the rates of shifts as compared to the last century? (Mach, Katharine, IPCC WGII TSU)
770	6	50	0	0	0	Section 6.6 up to and including 6.6.3. Misuse of bold Capital letters and an enormous number of often non-standard acronyms makes this section seriously hard to read. Why introduce all these acronyms in a Conclusions chapter? I'm sorry, but this just has to be changed. (Ottersen, Geir, Institute of Marine Research)
771	6	50	14	50	16	Can any distinctions in expected responses be drawn out--in the near-term versus the long-term, for high and low scenarios of climate change in the long-term? (Mach, Katharine, IPCC WGII TSU)
772	6	50	16	50	18	Overall, confidence is low "...that shifts in Bio-Geochemical processes (BG) are presently happening at detectable scales". This is contrary to much of the chapter where at least medium confidence is attributed to some of the processes. Stress that this low confidence applies to microbial processes. (UNITED STATES OF AMERICA)
773	6	50	22	0	0	Section 6.6. To the extent that it is possible to do so, the chapter team should consider characterizing risks for the near-term versus the long-term and for high and low scenarios of climate change in the long-term. Please see my overall comment on the chapter on characterizing future risks. Possible framing for the eras of climate responsibility and climate options could be considered. (Mach, Katharine, IPCC WGII TSU)
774	6	50	22	53	23	This whole section is really irritating as it uses acronyms throughout and seems to be required almost entirely to help explain figure 6-16. It basically repeats earlier text and serves no real function. It also undermines all the careful caveats and confidence assessments in the earlier sections. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
775	6	50	30	50	45	In this figure caption, attribution is established as relevant for observed and projected changes. If this is maintained (personally I would not encourage maintaining the approach), it is critical that all usage of the word "attribution" is very carefully considered in the text that follows to ensure that the reader understands in each instance whether the chapter team is discussing attribution in the context of observations or projections. (Mach, Katharine, IPCC WGII TSU)
776	6	50	48	53	23	Section 6.6.1 to 6.6.4: Ensure consistency with key assessment results and key conclusions/uncertainties from relevant WGI AR5 Chapters, i.e., Ch3 and Ch6 most importantly. In addition, many acronyms are introduced which are not used anywhere else in the WGII report. (Plattner, Gian-Kasper, IPCC WGI TSU)
777	6	50	48	53	48	In section 6.6 it is worthwhile to present the abbreviation once, as key to Figure 6.16. However, it will increase readability to not use the abbreviations in text but rather spell out the abbreviations in the section. (UNITED STATES OF AMERICA)
778	6	50	53	50	53	...300 Ma apart the Cretaceous/Tertiary boundary (Pecheux, Martin, Institut des Foraminifères Symbiotiques)

#	Ch	From Page	From Line	To Page	To Line	Comment
779	6	51	19	51	20	There is some need to be careful with this statement that OMZs will expand in the future with "high confidence". There is still considerable uncertainty as to the future evolution of low latitude hypoxic and suboxic waters in response to climate change (due to modelling deficiencies). For example, a statement on this from Ch06, WG1, Page 61: "[...] model predictions are speculative, especially concerning the evolution of O2 in and around oxygen minimum zones." (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
780	6	51	21	51	21	The chapter team could consider presenting "medium confidence" within parentheses at the end sentence. (Mach, Katharine, IPCC WGII TSU)
781	6	51	24	51	24	Are there data that calcifiers are currently being excluded because of CO2? Need to distinguish what IS happening from what is LIKELY to happen. (UNITED STATES OF AMERICA)
782	6	51	28	51	28	delete "e.g. through" and re place with "an example being" (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
783	6	51	28	51	38	Ocean acidification effects are given high levels of confidence in attribution and in projection, which seems at odds with the body of the text and with the levels of confidence in attribution and detection. (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
784	6	51	32	51	32	Note that Pacific oysters are introduced on US west coast - not adapted to high CO2 water (UNITED STATES OF AMERICA)
785	6	52	7	0	0	May be that should include viruses? (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
786	6	52	13	52	13	This sentence is not comprehensible. Please clarify. (UNITED STATES OF AMERICA)
787	6	52	13	52	15	Use of "low confidence" within the sentence could be considered. That is, it seems the author team actually does have higher confidence that such a concept is not available. (Mach, Katharine, IPCC WGII TSU)
788	6	52	15	52	16	The chapter team could consider presenting "low confidence" within parentheses at the end of the sentence. (Mach, Katharine, IPCC WGII TSU)
789	6	52	21	0	0	Term NPP is already defined on Page 4, line 32. (Ambulkar, Archis, Brinjac Engineering Inc.)
790	6	52	24	52	28	This statement is closer to correct and does not support the summary statement p19 line 29. (Lovejoy, Connie, Université Laval)
791	6	52	34	52	54	Herring to Pilchard (sardine) in English Channel (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
792	6	52	42	52	44	The comment on cod distributions seems very categorical when there is actually very little consensus on this issue. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
793	6	52	43	52	43	Instead of "causes," it would be clearer to say "has caused." (Mach, Katharine, IPCC WGII TSU)
794	6	53	0	0	0	The Frequently Asked Questions are much better written than chapter text. They provide a clear narrative that is easy and enjoyable to read. The main messages are presented in a clear and concise way. (AUSTRALIA)
795	6	53	19	53	19	Instead of very high confidence, state high confidence, as it is the general opinion (in fact bleaching is mainly due to OA, in prep) (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
796	6	53	26	53	45	This section (Sect 6.6.4) seems to be more about future recommendations than "Key Uncertainties" which are covered in implicitly in the previous section by reference to high and low confidence findings. Suggest to clarify. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
797	6	53	26	53	45	The paragraph here seems to address limitations of current science, rather than "Key Uncertainties". (Jung, Sukgeun, Jeju National University)
798	6	53	36	53	37	This is a very important point. It should be taken into consideration especially when assigning confidence levels to OA. (UNITED STATES OF AMERICA)
799	6	53	37	53	37	After ..."not been successful to date" it might be helpful to cite Le Quesne & Pinnegar (2012) [Fish and Fisheries 13: 333-344] (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)

#	Ch	From Page	From Line	To Page	To Line	Comment
800	6	53	48	0	0	In general, the FAQ in this chapter would benefit from further review and revision. Many of the FAQ are difficult to understand and the responses are quite long compared to FAQ in other chapters of the report. (CANADA)
801	6	53	48	55	51	FAQs seem inappropriate in an assessment. Consider eliminating them. The questions are fairly simple compared to the complexity of the text such that readers of the text would know the FAQ. The answers are comprehensive but long-winded. (UNITED STATES OF AMERICA)
802	6	53	50	0	0	Should the FAQ be worded as "Why are oceans fundamental to..." rather than "ocean life"? The response to the FAQ seems to address both physical and biological aspects. In general, the response is also quite long and could be more succinct. (CANADA)
803	6	53	50	0	0	FAQ 6-1 The answer needs to be condensed. At present it gives a lot of background. To be a short, to the point FAQ that is accessible to the wider audience the answer has to be 1/3rd its size and the language needs to be simplified without jargon. (Chatterjee, Monalisa, IPCC WGII TSU)
804	6	53	50	53	50	The phrase "fundamental to the planet's sensitivity" seems a bit of an awkward way to describe "ocean life," and it might be preferable to find a slightly more logically streamlined formulation. (Mach, Katharine, IPCC WGII TSU)
805	6	53	50	55	48	The replies to the frequently asked questions are much too long. (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
806	6	53	51	53	51	71% (in fact 70.8%) (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
807	6	53	51	53	51	This statement will leads to confusion "The life they contain creates about half of the oxygen (O2) we breathe" Human oxygen consumption is insignificant on global scale and most of marine O2 production is consumed locally (in the ocean) (UNITED STATES OF AMERICA)
808	6	53	52	53	53	The following statement can be misinterpreted. Most of the CO2 uptake is converted into inorganic carbon NOT into organic carbon as stated. "Oceans currently absorb ~25 % of the carbon dioxide (CO2) emitted from the burning of fossil fuels, convert it into organic matter and export part of it to the deep ocean" (UNITED STATES OF AMERICA)
809	6	54	6	54	14	I think it is better to delete the phrase "but difficult". (Jung, Sukgeun, Jeju National University)
810	6	54	15	54	24	This paragraph seems irrelevant to the question. (Jung, Sukgeun, Jeju National University)
811	6	54	21	54	21	is almost unprecedented (cf the K/T) (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
812	6	54	26	0	0	The word "special" here is difficult to interpret and implies climate change impacts on other systems are not "special". The response to the FAQ seems to imply that the point is that ocean life may be more sensitive to change than terrestrial life. Is this the case? If so, suggest focusing wording of the FAQ on this. (CANADA)
813	6	54	26	0	0	FAQ 6-2 The second part of the question can be deleted because the end of the answer essentially highlights the limitations that make it impossible to predict anything confidently at this point. That can be provided in one sentence and the question doesn't really need to highlight that component. (Chatterjee, Monalisa, IPCC WGII TSU)
814	6	54	31	54	31	...less alkaline, with more proton H+ concentration) (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
815	6	54	32	54	33	Question - "5 to 20 times lower CO2 levels in their blood" - lower than what? lower than land animals have, or lower than seawater? (Head, Erica, Fisheries and Oceans Canada)
816	6	54	50	0	0	The question FAQ 6.3 "How will marine ecosystems look like under climate change?" is ungrammatical. "What will they look like..." is better - but it is a very general question, and has the incorrect implication that ecosystem changes will necessarily result in changes in their visual appearance (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
817	6	54	50	0	0	The wording of this FAQ does not make sense and needs revising. It seems like the response is focusing on how marine ecosystems will respond to climate change. (CANADA)
818	6	54	50	0	0	This FAQ question is awkwardly worded. "What" instead of "How" ? (UNITED STATES OF AMERICA)

#	Ch	From Page	From Line	To Page	To Line	Comment
819	6	54	50	0	0	FAQ 6-3 The FAQ answer is very academic. The language needs to be simplified for a wider audience. (Chatterjee, Monalisa, IPCC WGII TSU)
820	6	54	50	54	50	"what" instead of "how" might make for better idiom here. (Mach, Katharine, IPCC WGII TSU)
821	6	55	11	55	11	After...."species richness" insert the phrase "at some sites." (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
822	6	55	21	55	21	The text should read " abundance of pathogens such as the agent causing cholera". (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
823	6	55	23	0	0	"sufficiently alkaline" will not be understand by a general audience. More simple wording is need for the FAQ and the concept should be better explained in the response. (CANADA)
824	6	55	23	0	0	I urge the authors to avoid using the term “alkaline” which is confusing because it can be associated to two very different ocean properties: pH and total alkalinity. (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
825	6	55	23	0	0	FAQ 6-4 is very text book type question. The language in this FAQ and answer is very technical and should be simplified to make it more accessible to a wider audience. Some sort of graphic may help. (Chatterjee, Monalisa, IPCC WGII TSU)
826	6	55	27	55	27	Add: Magnesium calcite (lager foraminifera) is even more soluble. (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
827	6	55	30	0	0	I urge the authors to avoid using the term “alkaline” which is confusing because it can be associated to two very different ocean properties: pH and total alkalinity. (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
828	6	55	31	55	31	If high CO2 levels or high H+ proton levels from outside (Pecheux, Martin, Institut des Foraminifères Symbiotiques)
829	6	55	36	55	48	The grammar in this section breaks down a bit and needs to be checked - in particular tenses. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
830	6	55	44	55	48	This does not seem to address the question (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
831	6	56	10	0	0	suggest adding "livelihoods" as well under "provisioning" services (McLeod, Elizabeth, The Nature Conservancy)
832	6	56	11	56	11	Oxygen supply from reefs is completely insignificant, delete: "supporting services (oxygen supply)" (UNITED STATES OF AMERICA)
833	6	56	14	56	18	This suggests evidence of OA effects in the 80's - this is not so. Please reword text to avoid this implication. (UNITED STATES OF AMERICA)
834	6	56	16	0	0	CC and OA did not "begin to occur" in the early 1980s - we first observed the impacts then but the processes were underway since the industrial revolution so would suggest adjusting this language (McLeod, Elizabeth, The Nature Conservancy)
835	6	56	16	56	16	The text should read " the most important and pervasive environmental variables". (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
836	6	56	17	56	18	The sentence that begins "As corals are centrally important" doesn't make sense. I would suggest replacing it with "Corals are extremely important as ecosystem engineers (Wild et al. 2011) and increasing water temperatures and acidity are contributing significantly to their widespread degradation." (Head, Erica, Fisheries and Oceans Canada)
837	6	56	25	56	25	Reference to figure "5X" needs to be updated with the appropriate figure number. (UNITED STATES OF AMERICA)
838	6	56	29	0	0	suggest adding 'reef-dependent' so it reads: "changes will erode reef-dependent fish habitats" (McLeod, Elizabeth, The Nature Conservancy)
839	6	56	40	56	45	See Brainard et al. 2012 ESA status review for coral risk related to climate and OA (UNITED STATES OF AMERICA)
840	6	57	9	57	44	References to figures in this section need to be updated with the appropriate figure numbers (e.g. lines 9, 33, 43, and 44). (UNITED STATES OF AMERICA)

#	Ch	From Page	From Line	To Page	To Line	Comment
841	6	57	28	0	29	"Although they are key conservation and management tools, they are less effecting in reducing coral loss from thermal stress (Selig et al. 2012)..." this part of the sentence is unclear and misleading. When it says, "they are less effective" - less effective than what? unprotected areas? Suggest clarifying to "Although they are key conservation and management tools, they are unable to protect corals directly from thermal stress (Selig et al. 2012)..... (Mcleod, Elizabeth, The Nature Conservancy)
842	6	57	30	0	0	while MPAs may need to be complemented by additional strategies (Rau et al. 2012) - they also MUST be implemented in a broader management framework that addresses threats outside their boundaries. This is a critical omission and suggest the following to address it: Before sentence beginning "Controlling the input of nutrients..." suggest adding "While MPA networks are a critical management tool for conserving marine biodiversity, they must be established in conjunction with other management strategies to be effective. MPA networks should be established considering other forms of resource management (e.g., fishery catch limits and gear restrictions) and integrated ocean and coastal management to control land-based threats such as pollution and sedimentation. The most effective configuration may be networks of highly protected areas nested within a broader management framework (Salm et al. 2006). Such a framework might include an extensive multiple-use area integrated with coastal management regimes that help minimize land-based sources of pollution (Mcleod et al. 2009). Salm RV, Done T, and Mcleod E. 2006. Marine protected area planning in a changing climate. In: Phinney JT, Hoegh- Guldberg O, Kleypas J, et al. (Eds). Coral reefs and climate change: science and management. Washington, DC: American Geophysical Union. Mcleod, E., R. Salm, A. Green, and J. Almany. 2009. Designing marine protected area networks to address the impacts of climate change. Frontiers in Ecology and the Environment 7(7): 362-370. (Mcleod, Elizabeth, The Nature Conservancy)
843	6	57	32	0	0	suggest editing sentence to: "Controlling the input of nutrients and sediment from land is an important complementary management strategy because nutrient enrichment can increase the susceptibility of corals to bleaching (Wiedenmann et al. 2012) and coastal pollutants enriched with fertilizers can increase acidification (Kelly et al 2011). Additionally, management of herbivore fishing will be increasingly important to support reef resilience as faster growing algae will be more likely to outcompete slower growing and stressed corals in warmer and acidified seas (Anthony et al 2011; Mcleod et al. 2012)." Kelly RP, Foley MM, Fisher WS, et al. 2011. Mitigating local causes of ocean acidification with existing laws. Science 332: 1036–37. Anthony KRN, Maynard JA, Diaz-Pulido G, et al. 2011. Ocean acidification and warming will lower coral reef resilience. Glob Change Biol 17: 1798–808. Mcleod, E., K.R.N. Anthony, A. Andersson, R. Beeden, Y. Golbuu, J. Kleypas, K. Kroeker, D. Manzello, R. Salm, H. Schuttenberg, and J.E. Smith. 2012. Preparing to manage coral reefs for ocean acidification: Lessons from coral bleaching. Frontiers in Ecology and the Environment. doi:10.1890/110240. (Mcleod, Elizabeth, The Nature Conservancy)
844	6	58	0	0	0	Box OA appears to have been duplicated in both chapters 5 and 6. (Kheshgi, Haroon, ExxonMobil Corporate Strategic Research)
845	6	58	46	61	38	This box (on ocean acidification seems unnecessary as almost everything here is included in the chapter text, where it is substantially better written! (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
846	6	59	13	59	13	Reference to figure WGII, Figure 6.28 should actually be WGI, Figure 6.28. (UNITED STATES OF AMERICA)
847	6	59	28	59	28	Do seaweeds really compete with snails (this is how the sentence reads). Also I'm not sure I would label marine gastropods 'snails' as this might confuse the reader (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
848	6	59	29	59	29	What are "ecosystem builders"? Avoid use of jargon (UNITED STATES OF AMERICA)
849	6	59	34	59	34	Should mention the possibility of potential 'bottom up' impacts through marine food-webs. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
850	6	60	33	60	35	See the comment to (Chapter 5, Page 50, Lines 26-28) (Ryaboshapko, Alexey, Institute of Global Climate and Ecology)

#	Ch	From Page	From Line	To Page	To Line	Comment
851	6	60	45	60	45	Also see Roberts et al (2013) [Global Change Biology, 19: 340-351.] on the interaction between metal toxicity/pollution and ocean acidification. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
852	6	80	34	0	0	The publication date of Joint et al. is 2011 (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
853	6	122	36	122	36	In accordance with comment above (ch 6, p 29 line 23), add reference: Valdimarsson H., O. S. Astthorsson and J. Pálsson, 2012. Hydrographic variability in Icelandic waters during recent decade and related changes in distribution of some fish species. ICES Journal of Marine Science, 69(5), 816-825. (ICELAND)
854	6	124	0	0	0	Table 6-1: The term 'invader on macrofauna' is unclear (Row 4, Column 5), and in Row 6, Column 5, the second dot point should say 'large photosynthetic eukaryotes'. (AUSTRALIA)
855	6	124	0	0	0	Table 6-1. In the "English Channel and later into the open sea" section the Plymouth MBA time series should be listed here: Russell et al., 1971, Russell, 1973; Southward 1980; Southward et al., 1995, 2005; Hawkins et al., 2003. 1900- Date with gaps. Russell FS, Southward AJ, Boalch GT, Butler EI. 1971. Changes in biological conditions in the English Channel off Plymouth during the last half century. Nature 234:468-470. F. S. Russell. 1973. A Summary of the Observations on the Occurrence of Planktonic Stages of Fish off Plymouth 1924–1972. Journal of the Marine Biological Association of the United Kingdom, 53, pp 347-355. Southward AJ, Hawkins SJ, Burrows MT. 1995. Seventy years' observations of changes in distribution and abundance of zooplankton and intertidal organisms in the western English Channel in relation to rising sea temperature. Journal of Thermal Biology 20 (1-2): 127-155. Southward AJ, Langmead O, Hardman-Mountford NJ, Aiken J, Boalch GT, Dando PR, Genner MJ, Joint I, Kendall M, Halliday NC, et al. 2005. Long-term oceanographic and ecological research in the Western English Channel. Advances in Marine Biology 47: 1-105. Hawkins SJ, Southward AJ, Genner MJ. 2003. Detection of environmental change in a marine ecosystem – evidence from the western English Channel. Science of the Total Environment 310: 245-246. (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
856	6	124	0	0	0	Table 6.1: Include confidence or likelihood assessment in the interpretation. (UNITED STATES OF AMERICA)
857	6	124	0	0	0	Table 6-1. Within the 1st entry in this table, it would be helpful to clarify what is meant by "robust projections"--projections of future effects or model-based understanding of observed changes? (Mach, Katharine, IPCC WGII TSU)
858	6	124	0	124	0	Table 6-1 (page 124) with regard to satellite chlorophyll data it would be good to mention that the Coastal Zone Colour Scanner (1978-1986) existed before SeaWiFS. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
859	6	125	0	0	0	Table 6-2. The chapter team should consider deleting this textbook-like table. (Mach, Katharine, IPCC WGII TSU)
860	6	125	0	125	0	Can't quite see what this table (Table 6-2) adds (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
861	6	126	0	0	0	Table 6.3: Specify approximate latitude ranges of Southern Ocean and low latitude gyre. (UNITED STATES OF AMERICA)
862	6	126	0	0	0	Table 6-3: "Degree of" what? (Estrada, Yuka, IPCC WGII TSU)
863	6	127	0	0	0	Table 6-4: It would be more useful to link this table with Figure 6-6 more clearly, or it would be more efficient if this table were combined with Figure 6-6. For instance, it will provide more information if this table shows where each process is depicted in figure 6-6. (Estrada, Yuka, IPCC WGII TSU)
864	6	128	0	0	0	Table 6-5: In the coral section, the studies cited above should be added. It might be good to have a separate field for cold-water corals as their tolerance limits for pCO ₂ are higher than that of tropical corals and the confidence is also higher with all studies confirming a high pCO ₂ tolerance (if negatively impacted the pCO ₂ clearly above 1000 µatm). (Maier, Cornelia, Laboratoire d'Océanographie de Villefranche sur Mer)
865	6	128	0	0	0	Table 6.5: RCP scenarios do not consider in situ pH. Assuming atmospheric equilibrium can be very misleading. See McElhany and Busch 2012. Statements on potential error due to this reason should be included in discussion in the text. (UNITED STATES OF AMERICA)

#	Ch	From Page	From Line	To Page	To Line	Comment
866	6	128	0	0	0	Table 6-5. It seems this table is supported by a large number of relevant citations, yet few are given. It should be clarified where the reader should look to understand the supporting references. Additionally, for the final 2 columns in the table, the relevant time frame for tolerance should be specified within the table headings--2100 I believe? (Mach, Katharine, IPCC WGII TSU)
867	6	128	0	130	0	Table 6-5 and 6-6 are very inadequate. (1) They are incomplete, with references missing. (2) information is missing in 6-5 such as the papers considered. (3) Whether the changes are beneficial or detrimental is not based on statistics, hence it is subject to personal biases. (4) pH values expressed on different scales are reported, leading to extreme confusion for comparison. In contrast to the legend, the difference of pH depending on the scale can be higher than 0.15 (which is already a huge difference, larger than the average pH difference between preindustrial time to today). (5) pCO2 values in ppm are reported, it should be μatm . These table should be replaced by tables or figures from the latest and most complete metanalysis of Kroeker et al. (2013). (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
868	6	129	0	0	0	Table 6.6: Change caption "Also note that the pH scale used was not always reported" to "Also note that the pH scale and temperature used was not always reported." (UNITED STATES OF AMERICA)
869	6	129	0	0	0	Table 6.6: Include assessment of confidence. (UNITED STATES OF AMERICA)
870	6	129	1	0	0	Table 6-6. Is "synergistic effect" necessarily applicable to all the examples given? The term 'synergy' is frequently mis-used; it is not the same as 'additive'. For discussion, see: Dunne RP (2010) synergy or antagonism - interactions between stressors on coral reefs. Coral Reefs 29, 145-152). (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
871	6	131	0	0	0	"Shift from sardines (<i>Sardinops melanostictus</i>) to anchovies (<i>Engraulis japonicus</i>) in the Sea of Japan observed between 1993 and 2003" should be amended to "Shift from sardines (<i>Sardinops melanostictus</i>) to anchovies (<i>Engraulis japonicus</i>) in the western North Pacific observed between 1993 and 2003" in the second line of column "Phenomenon" of Table 6-7, in order to maintain consistency with description in the quoted document. (JAPAN)
872	6	131	0	0	0	Table 6.7 seems very incomplete. Please check recent literature for additional examples. (UNITED STATES OF AMERICA)
873	6	131	0	0	0	Table 6.7: Under the column heading "Phenomenon" last box, the reference to figure 6-9B is incorrect. This may be a figure from WGI doc and should be referenced as such. (UNITED STATES OF AMERICA)
874	6	131	0	0	0	Table 6-7. It would be helpful to clarify the entries relevant to the 1st column of this table, for each row of the table. Additionally, the relevant time frame for all "phenomena" provided within the 2nd column should be specified. (Mach, Katharine, IPCC WGII TSU)
875	6	131	0	131	0	Table 6-7 - Would be good to cite Simpson et al (2011b) [in the first row] - already included in the reference list. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)

#	Ch	From Page	From Line	To Page	To Line	Comment
876	6	133	0	0	0	Table 6-8. "Species abundance, biogeography and diversity" Much work on expansion of UK warm water rocky shore species: Southward, 1991; Southward et al., 1995; Herbert et al., 2003, Mieszkowska et al., 2007, Helmuth et al., 2006; Hawkins et al., 2008, 2009; Poloczanska et al., 2008. A. J. Southward (1991). Forty Years of Changes in Species Composition and Population Density of Barnacles on a Rocky Shore Near Plymouth. Journal of the Marine Biological Association of the United Kingdom, 71, pp 495-513. Southward AJ, Hawkins SJ, Burrows MT. 1995. Seventy years' observations of changes in distribution and abundance of zooplankton and intertidal organisms in the western English Channel in relation to rising sea temperature. Journal of Thermal Biology 20 (1-2): 127-155. Herbert, R. J. H., Hawkins, S.J., Sheader, M., Southward, A.J., 2003. Range extension and reproduction of the barnacle <i>Balanus perforatus</i> in the eastern English Channel. Journal of the Marine Biological Association of the United Kingdom, 83: 73-82. Mieszkowska, N., Hawkins, S.J., Burrows, M.T., Kendall, M.A., 2007. Long-term changes in the geographic distribution and population structures of <i>Osilinus lineatus</i> (Gastropoda: Trochidae) in Britain and Ireland. Journal of the Marine Biological Association of the United Kingdom, 87: 537-545. Helmuth B, Mieszkowska N, Moore P, Hawkins SJ. 2006. Living on the edge of two changing worlds: forecasting responses of rocky intertidal ecosystems to climate change. Annual Review of Ecology, Evolution and Systematics 37: 373-404. Hawkins, S.J., Moore, P., Burrows, M.T., Poloczanska, E., Mieszkowska, N., Jenkins, S.R., Thompson, R.C., Genner, M.J., Southward, A.J., 2008. Complex interactions in a rapidly changing world: responses of rocky shore communities to recent climate change. Climate Research, 37: 123-133. Hawkins, S.J., Sugden, H.E., Mieszkowska, N., Moore, P., Poloczanska, E., Leaper, R., Herbert, R.J.H., Genner, M.J., Moschella, P.S., Thompson, R.C., Jenkins, S.R., Southward, A.J., Burrows, M.T., 2009. Consequences of climate driven biodiversity changes for ecosystem functioning of North European Rocky Shores. Marine Ecology Progress Series, 396: 245-259. Poloczanska ES, Hawkins SJ, Southward AJ, Burrows MT. 2008. Modelling the response of populations of competing species to climate change. Ecology 89 (11): 3138-3149. (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
877	6	133	0	0	0	Figure 6-8 is referenced earlier in the text on page 12, L 46 and should be inserted at that point in the chapter. (UNITED STATES OF AMERICA)
878	6	133	0	0	0	Table 6.8: Include an assessments of confidence. (UNITED STATES OF AMERICA)
879	6	133	0	0	0	Table 6-8. The timeframe for all examples of observed changes within this table should be specified. (Mach, Katharine, IPCC WGII TSU)
880	6	133	0	133	0	Table 6-8 (bottom). You could include an almost identical line for the Northeast Atlantic citing Simpson et al (2011b) - already included in the reference list. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
881	6	134	0	0	0	Table 6-8. "Phenology" Warming did not really kick off until 1987 around the UK. (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
882	6	134	0	0	0	Table 6-8 "Trophic and competitive interactions" Shifts in invertebrate and algal groups in British Waters especially in competition between barnacles (Poloczanska et al., 2008). Poloczanska ES, Hawkins SJ, Southward AJ, Burrows MT. 2008. Modelling the response of populations of competing species to climate change. Ecology 89 (11): 3138-3149. (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
883	6	134	0	0	0	Table 6.5: AR5 Chapter 6, Page 134, Table 6-5 (Responses and attribution), Phenology, the response of changes in salmon timing related to long-term warming (Kovach et al. 2012) is not balanced against the finding cited in Chapter 28 of lack of changes in salmon timing in the absence of long-term warming (Mundy and Evenson 2011 in references Chapter 28 but incorrectly cited, see comments on Chapter 28, Start Page Number 31, Start Line Number 8, End Page Number, 31 End Line Number, 9). (UNITED STATES OF AMERICA)

#	Ch	From Page	From Line	To Page	To Line	Comment
884	6	135	0	0	0	Table 6-9. "Individual species" Insert Genner et al., 2010 and Simpson et al., 2011 Genner MJ, Sims DW, Southward AJ, Budd GC, Masterson P, Mchugh M, Rendle P, Southall EJ, Wearmouth VJ, Hawkins SJ. 2010. Body size-dependent responses of a marine fish assemblage to climate change and fishing over a century-long scale. Global Change Biology 16: 517-527. Simpson SD, Jennings S, Johnson MP, Blanchard JL, Schon PJ, Sims DW, Genner MJ. 2011. Continental shelf-wide response of a fish assemblage to rapid warming of the sea. Current Biology 21 (18): 1565-1570. (HAWKINS, STEPHEN, UNIVERSITY OF SOUTHAMPTON)
885	6	135	0	0	0	Figure 6-9: Reference to figure 6-10 is made in the text before figure 6-9 (UNITED STATES OF AMERICA)
886	6	135	0	0	0	Table 6.9: Use confidence limits rather than "???". If, as the caption state there is insufficient number of studies, the confidence would be very low (UNITED STATES OF AMERICA)
887	6	135	0	0	0	Table 6-9. It would be preferable to indicate more specifically what is meant by "defines the bounds of our understanding"--the nature of the interaction is not understood? (Mach, Katharine, IPCC WGII TSU)
888	6	135	5	135	40	Table 6-9 seems not to be complete. In almost every box a reference seems to be missing (only E, O and M are listed and in some only question marks (?) (ICELAND)
889	6	136	0	0	0	You should add (for example in the title of the table) that knowledge on proposed geoengineering methods is in general very limited and that it could be revised by possible future findings. (GERMANY)
890	6	136	0	0	0	Figure 6-10: There are no letter divisions in figure 6-10. This problem occurs again on p24, lines 5, 11, and 21, and on p25, lines 1, 28, 30. (UNITED STATES OF AMERICA)
891	6	136	0	0	0	Table 6.10 should include all of the proposals discussed in section 6.4.2.1, including addition of alkalinity (UNITED STATES OF AMERICA)
892	6	136	0	0	0	Tabel 6-10 under Sub-sea geological storage: Because the storage does not only need to be an aquifer (e.g. could also be old gas fields etc) and to be in line with commonly used language we propose that the text "a porous submarine aquifer" should be rep (NORWAY)
893	6	137	0	0	0	Figure 6.1: Use better scale demarkations (e.g. instead of 0.22, 0.47, 1.01,2.19, 4.73 and 10.21 use 0.2,0.5, 1,2,5,and 10) (UNITED STATES OF AMERICA)
894	6	137	0	138	0	Figure 6-1 & Figure 6-2: Robinson projection is the recommended projection for global maps. Please ensure this projection is used wherever possible to have a consistent presentation across the volume. (Estrada, Yuka, IPCC WGII TSU)
895	6	138	0	0	0	Fig.6-2A\B There is a mistake on °C (Ye, Siyuan, Qingdao institute of marine geology)
896	6	138	0	0	0	Figure 6-2 A contains a world map with national borders. It is suggested to use a map without borders to avoid unnecessary disputes. (CHINA)
897	6	138	0	0	0	Figure 6.2: Panel D and the associated legend is difficult to comprehend. E.g. what does the following mean: "The spatial distribution of variability by time scales was computed by accumulating the relative spectral densities of each 2 x2 grid box frequency-transformed series by frequency windows, corresponding to the multidecadal (period >25 years), bidecadal (15 to 25 years), decadal (8 to 15 years), low ENSO frequency (5 to 8 years), high ENSO frequency (3 to 5 years) and very high frequency (2 to 3 years) scales. " (UNITED STATES OF AMERICA)
898	6	138	0	0	0	Figure 6-2. For the color bars provided for part A, is it possible to provide more ability to distinguish the different temperatures within the shades of blue and red used, potentially by introducing further colors? For part B, the timeframe could be clarified--1911-2011 presumably, which could be indicated within the color bar caption. For part D, the phrase "temperature class interval" is 1st introduced within the caption while the phrase "interannual variability intervals" is used within the figure itself. It might be clearest to make the figure label match the primary term used within the caption. (Mach, Katharine, IPCC WGII TSU)

#	Ch	From Page	From Line	To Page	To Line	Comment
899	6	139	0	0	0	Figure 6-3 and legend. This is a complex figure that demands a more detailed legend. For example, what does "migration" refer to in the upper panels? Are the numbers given for "Extinction [# species]" correct? These numbers strike me as being awfully small for the PETM extinction. Suffice to say, the legend needs to be expanded considerably to make the figure interpretable. (Somero , George , Stanford University)
900	6	139	0	0	0	Figure 6.3: Extinction axis label is confusing because axis is not extinction. Please clarify. (UNITED STATES OF AMERICA)
901	6	139	0	0	0	Figure 6-3: The way this figure is laid out invites readers to compare the trends of the historical record on the left to the modern record on the right. A lot of different data are presented here, which inevitably makes it difficult to make direct comparisons, in particular for the middle two rows. Thus, more explanation in the figure caption are required for the middle two rows. [Temperature] It is not clear exactly what the charts are showing without explanation in the caption. What is the difference between the orange and red lines in the right panel? Red and orange colors are also hard to distinguish from each other. [Extinction] The right side of the panel can be confusing with the amount of data presented. The green and red lines are crowded enough together that it is difficult to associate which scale they belong to. Please define "AMO T" in the caption. Also, y-axes overlap, which adds further confusion. Please fix this. (Estrada, Yuka, IPCC WGII TSU)
902	6	139	0	0	0	Figure 6-3. In the top portion of this figure, would it be clearest to make the y-axis label "migration (percent of warm water species)," reversing the placement of the percentage sign? Additionally, the caption suggests that these data are for 2 types of plankton, which could be specified within the labeling of the figure itself. For the 2nd set of graphs within the figure, the metric for extinction could be clarified--is the number of species the number of species that went extinct, or the total number of species in the record? The acronym AMOT should be spelled out. Additionally, it seems the 2nd panel pertains only to benthic foraminifera, which could be labeled in the graphic itself. (Mach, Katharine, IPCC WGII TSU)
903	6	139	0	139	0	Not sure how to interpret this figure (Fig 6-3) as multiple localities. Are we inferring cause and effect?? (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
904	6	140	0	0	0	Figure 6.4: Consider deleting the figure. It is not that informative and several of the scales are questionable (e.g. moorings at 1 dm) (UNITED STATES OF AMERICA)
905	6	140	0	0	0	Figure 6-4: Can you distinguish different types of processes (physical, vs physiological, vs ecological) by using different colors or shades? (Estrada, Yuka, IPCC WGII TSU)
906	6	140	0	0	0	Figure 6-4. As a minor point, the acronym MLD should be spelled out in the caption at least. (Mach, Katharine, IPCC WGII TSU)
907	6	141	0	141	0	Not really clear how this figure (fig 6-5) goes with the paragraph above (on page 11) (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
908	6	142	0	0	0	Figure 6-6: This figure needs to be linked better with Table 6-4 to convey the information more effectively. It is implied that processes (labels) occur at certain depths. This should be explicitly mentioned. (Estrada, Yuka, IPCC WGII TSU)
909	6	143	0	0	0	Figure 6.7: panel A. It is not necessary to include units for temperature, oC, since there are no values listed on the axis. Panels C and D are difficult to interpret (UNITED STATES OF AMERICA)
910	6	143	0	0	0	Figure 6-7. The labeling of the spring warming cue could be clarified in part C. (Mach, Katharine, IPCC WGII TSU)
911	6	143	0	144	0	Figure 6-7: The figure caption needs be comprehensible to non-experts and all elements of the figure need to be explained, so that it can stand alone. The non-descriptive axes give no indication in y of directionality. On the other hand, the x-axis simply states cold-to-warm without giving the reader any idea of what "cold-to-warm" is. Please clarify the difference between Tcritical and Tc –and Tpeju and Tp. It is not clear what "spring warming cue" is pointing out. Please clarify how to interpret the arrows indicating phonological shift, the expansion and contraction are both pointing upwards. (Estrada, Yuka, IPCC WGII TSU)

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912	6	147	0	0	0	Legend to Figure 6-9: "resident" biota (Somero , George , Stanford University)
913	6	147	0	0	0	Figure 6-9.The mechanisms of the figure are unclear and possibly appears misleading. See my comment for page 19. line 39. (Aksnes, Dag Lorents, University of Bergen)
914	6	147	0	0	0	I strongly advise not to use the word "acidic". The definition of "acidic" in the Oxford English dictionary is "having the properties of an acid; having a pH of less than 7". Despite the process of ocean acidification (the acidity of seawater has increased 26% since preindustrial time), the oceans are alkaline (pH higher than 7) and will not become acidic in the foreseeable future. Hence, the "acid" or "acidic" should not be used when referring to seawater. Note that there are few exceptions, seawater can be acidic in the immediate vicinity of CO2 vents or in purposeful perturbation experiments, but this is not a concern in this chapter. (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
915	6	147	0	0	0	Figure 6-9: What does "fresher" really mean? Also, please clarify what the white solid and dashed lines are illustrating. (Estrada, Yuka, IPCC WGII TSU)
916	6	147	0	0	0	Figure 6-9. Within this caption, the relevant chapter sections where further assessment of the topics can be found could be specified with line-of-sight references. (Mach, Katharine, IPCC WGII TSU)
917	6	147	1	147	6	Completely misleading diagram. The sea is not uniform but highly variable. There are some regions at present which actually emit carbon dioxide, so they are saturated, There is no evidence that the organisms present are harmed, though they are probably ones which favour the circumstances. Increases in carbon dioxide will only slightly increase these regions and slightly decrease those regions that have less carbon dioxide. Therefore neither of the extremes in this diagram will ever exist. (Gray, Vincent, Climate Consultant)
918	6	148	0	0	0	Figure 6-10: This figure could be clearer in terms of relationship between tissues and intracellular space and the direction of the effect of pH on processes. (AUSTRALIA)
919	6	148	0	0	0	Fig. 6-10: The top part of this figure is extremely specialized and is not useful in the context of this chapter. (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
920	6	148	0	0	0	Fig. 6-10B: This chapter uses the paper of one of the authors (Wittmann and Pörtner, sbm) while not mentioning other papers which, in my view, are statistically more sound (for example Kroeker et al., 2013 which addresses some of these functions as well as the effects on larval stages). (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
921	6	148	0	0	0	Fig. 6-10B: almost half of the bars (those above 1370 μ atm) have no environmental relevance for the present century, hence with this chapter, and should be removed. (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
922	6	148	0	0	0	Figure 6-10. Within the schematic, the blue line indicates the organism, but it also seems that the outer black lines also specified the exterior of the organism--should this be clarified?? (Mach, Katharine, IPCC WGII TSU)
923	6	148	0	148	0	Not clear in the figure caption (fig 6-10) if this is based on a meta-analysis or modelling??? Also is it permissible to include reference to a submitted rather than published source? (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
924	6	150	0	0	0	Fig.6-11: The latitude scale is not correct (Ye, Siyuan, Qingdao institute of marine geology)
925	6	150	0	150	0	The figure is ok (fig 6-11) but the panels are arranged in a bit of a confusing format. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
926	6	152	0	0	0	Figure 6.12: The authors should eliminate term "Red tide and CO2 acidification"- this will lead to confusion suggesting these are underlying mechanisms for hypoxia. (UNITED STATES OF AMERICA)
927	6	156	0	0	0	in figure B change m by km when indicate the median shift in latitude (Anadon, Ricardo, University of Oviedo)
928	6	156	0	0	0	Figure 6.15: The authors should include a description of a box and whiskers plot in panel B. Also, convert poleward shift to a likelihood scale in text. (UNITED STATES OF AMERICA)

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929	6	156	0	0	0	Figure 6-15: The benefit of having sections A and B presented together with C and D as a single figure suffers greatly due to a lack of adequate explanation in the figure caption. The non-expert is asked to make the connections which are too much to ask. The language used for labeling the axes and chart titles is unnecessarily technical, making it harder to understand for the non-expert as well. Consider a thorough revision of the caption in order to properly convey the ideas being communicated here. (Estrada, Yuka, IPCC WGII TSU)
930	6	157	0	0	0	Figure 6-15C/D contains a world map with national borders. It is suggested to use a map without borders to avoid unnecessary disputes. (CHINA)
931	6	157	0	0	0	Figure 6-15. In the caption for this figure, it seems that "scenarios" may not be the clearest word. One option would simply be to start a caption with "climate change effects" with deletion of "scenarios of." Then, is "hypothesis" the best descriptor for the 1st panel--perhaps "a schematic of hypothesized interactions"? Finally, is panel D simply an "example"? Word choice could be considered. (Mach, Katharine, IPCC WGII TSU)
932	6	158	0	0	0	I suggest to incorporate on the top of figures Detection (left side of graphs) and Projections (right side of the graphs) to a more easily understanding of the figure (Anadon, Ricardo, University of Oviedo)
933	6	158	0	0	0	Figure 6.16: The authors should point out that confidence in attribution is strongly related to confidence of detection. (UNITED STATES OF AMERICA)
934	6	158	0	0	0	Figure 6.16: The authors should use the Abbreviations rather than [Roman] numbers in graph as it takes as much space and abbreviations can be remembered rather than having to resort to the key (UNITED STATES OF AMERICA)
935	6	158	0	0	0	Ocean acidification effects are given high levels of confidence in attribution and in projection, which seems at odds with the body of the text and with the levels of confidence in attribution and detection. (Gattuso, Jean-Pierre, Centre National de la Recherche Scientifique)
936	6	158	0	0	0	Figure 6-16. The chapter team is strongly encouraged to present this information within a table, perhaps incorporating colors and symbols within the table to communicate levels of confidence. Additionally, it would be preferable to indicate projected outcomes and the relative importance of climate change for them, without using the term attribution in the context of projection. (Mach, Katharine, IPCC WGII TSU)
937	6	160	0	0	0	Figure CR-1: In the figure caption, there are references to figures XB and XA. These need to be updated with the appropriate references. (UNITED STATES OF AMERICA)
938	6	161	0	0	0	Figure OA-1: The ordering of sub-figures within this figure needs to be changed to reflect order of reference in the text. Figure B should be relabelled A, C should be relabelled B, and A should be relabelled C. Figure formatting should also be changed to reflect this ordering. Additionally, figure A is missing references to figures in the WGI report and from chapters 5, 6, and 30 of the WGII report. These need to be updated with the appropriate references. (UNITED STATES OF AMERICA)
939	6	161	0	0	0	Figure OA-1A: Reference to figure OA-1A should be made at the end of this sentence. (UNITED STATES OF AMERICA)
940	6	161	0	0	0	Figure OA-1B: Reference to figure OA-1B should be made at the end of this sentence. (UNITED STATES OF AMERICA)
941	6	161	0	0	0	Figure OA-1C: Reference to figure X.C should be changed to figure OA-1C. (UNITED STATES OF AMERICA)