

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
1	56570	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). (Archis Ambulkar, Brinjac Engineering Inc.)	Most terms are described at first appearance, or included in the general glossary.
2	57008	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. (Salif Diop, UNEP - SAB - DEWA)	Thanks for the reference, we have consulted the document and found valuable information and encouraging coincidences with our chapter focus.
3	57228	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 (Erica Head, Fisheries and Oceans Canada)	We appreciate the references. We have reviewed and included them when suitable. However, in most cases we found no divergent information from that already included in the chapter.
4	57584	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. (George Somero , Stanford University)	We have reduced redundancies through the text. The chapter was reorganized and some sections rewritten.
5	57785	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 acidification 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. (Ronald Stouffer, Geophysical Fluid Dynamics Laboratory/NOAA)	OA is used through the entire chapter and defined at first appearance. We now spell it out more frequently, the frequent use of the word ocean acidification made it necessary to use the acronym as well. We are only using OAE when describing figure 6-15.
6	58263	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. (Juqi Duan, National Climate Center, Chinese Meteorological Administration)	Chp 6 is sectoral. The regional-scale issues, including adaptation, belongs to Chapter 30 (regional).
7	58528	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. (Janice Lough, Australian Institute of Marine Science)	Chapter has been restructured and edited.
8	58875	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. (Svein Sundby, Institute of Marine Research)	There is a vast number of possibilities to structure the information and we decided to structure along drivers and processes, as this allows taking the complexity of the processes into account.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
9	59894	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)	Chapter has been restructured, rewritten and edited.
10	59895	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)	Such section is now included, dealing with chapters 5, 6 and 30. We also included references to other chapters dealing with marine issues (22-29).
11	59896	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)	Chapter has been restructured, rewritten and edited.
12	61091	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). (European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)	Chapter has been restructured, rewritten and edited.
13	62492	6	0	0	0	0	Bioinvasion in relation to climate change has not been dealt (INDIA)	We have included few lines dealing with this topic in the section 6.5.
14	63515	6	0	0	0	0	Please shorten and simplify the FAQs in this chapter and use a style similar to the other chapter. (GERMANY)	FAQs have been restructured and simplified.
15	64469	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 recieved quite a lot of attention within the last decade. Therefore, I suggest to add this species as an example. (Teunis Jansen, Danish Technical University - National Institute of Aquatic Resources)	We appreciate the comment, but found no opportunity to include specific examples giving diverging or additional information to that already included in the chapter.

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16	65027	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. (George Hunt, University of Washington)	We appreciate the comment, however, it was agreed that to avoid major overlaps the high latitude marine ecosystems are dealt with in more detail in chapter 28, and to some extent in the regional chapter 30.
17	65309	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. (Shin-ichi Ito, Fisheries Research Agency, Tohoku National Fisheries Research Institute)	Thanks for the recommendation. We are actively crossreferencing between both chapters and reducing the overlap through crosschapter boxes and other strategies.
18	66252	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. (Geir Ottersen, Institute of Marine Research)	Thanks for the recommendation. We are actively crossreferencing between both chapters and reducing the overlap through crosschapter boxes and other strategies
19	68887	6	0	0	0	0	To avoid confusion with chapter 30 ("The Ocean") this chapter should be named "Ocean Eco-Systems". (NETHERLANDS)	We appreciate the comment, however changing the chapter title is not in our hands.
20	72317	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)	We have rearranged sections 6.2 and 6.3 to better stress specific responses of different organisms and groups to climate change (from microorganisms to megafauna), including temperature, ocean acidification, hypoxia and combined factors. The question about microorganisms touches on an unresolved issue that could not be addressed.
21	72318	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)	Agreed, we have included a short definition as suggested
22	72319	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)	Chapter has been restructured, rewritten and edited
23	72320	6	0	0	0	0	Chapter 6 never discusses sea level rise. Why? This seems an important omission. (UNITED STATES OF AMERICA)	Sea level rise is a chapter 5 (coasts) key issue. How we see our chapter in relation to others is outlined in a new introductory section with references to other marine chapters
24	72321	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)	Chapter has been restructured, rewritten and edited
25	72322	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)	Section is being rewritten. A specific section on long-lived marine mammals, reptiles and birds is included.

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26	72323	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)	The different stressors potentially affecting biota are now treated in section 6.3, including a section on the combined action of drivers. We have modified the executive summary accordingly. The complexity of interactions between drivers should now be clearer.
27	72324	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)	We appreciate the comment. We have revised the use of calibrated language through the entire chapter.
28	72325	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)	We are not aware of such a comparison.
29	72326	6	0	0	0	0	Please make % of earth covered by water consistent, 71 vs 70% given on 2 pages. (UNITED STATES OF AMERICA)	We now write 71%, and assured consistency within this chapter and with ch30
30	72327	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)	A clear and concise definition has now been provided, first in the Executive Summary.
31	72328	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)	We clarified the time scales and coordinated with Chapter 30 , The current rate and magnitude of ocean acidification is unprecedented within the last 65 Ma (high confidence, Ridgwell and Schmidt 2010) or even 300 Ma of Earth history (medium confidence, Hönisch et al., 2012).
32	72329	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)	We now assured that the confidence statements are in brackets where they are used. A table is not an option because it would increase the page count and the crossreferencing during reading would be complicated.
33	72330	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)	We have restructured the chapter, and now provide one conclusion at the end of each main paragraph.
34	72331	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)	We have restructured the chapter, and now provide one conclusion at the end of each main paragraph.

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35	72332	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)	We have restructured the chapter, and compiled more cross-chapter boxes in order to minimize overlap.
36	72333	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)	Agreed, its virtually impossible to include all examples and citations to all relevant papers. We have reviewed the suggested document and used it to track relevant issues with an emphasis on what can or cannot be reliably assessed. Thanks for the recommendation.
37	72334	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)	We appreciate the comment. We have revised the use of calibrated language throughout the entire chapter.
38	72335	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)	This point is well taken and we have made sure to distinguish between the future trends which may have high confidence and the quantitative outcomes which have low or medium confidence due to uncertainties in the underlying mechanisms and the simplifications made during ecosystem modeling.
39	72336	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)	A roadmap has been added to guide the reader between chapters 5/28/29/30 to allow understanding the remits of each of the chapters.
40	72337	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)	We appreciate the comment. We have revised the use of calibrated language through the entire chapter.
41	72338	6	0	0	0	0	This same statement applies for ocean acidification. (UNITED STATES OF AMERICA)	Ocean acidification has been addressed with the production of a cross chapter box on ocean acidification across Ch 30, 6 and 5. By consistently using confidence language we hope to more clearly distinguish firm knowledge from extrapolated conclusions.
42	72339	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)	Salinity is important in polar and coastal regions, otherwise temperature is more important. We now emphasize density more.

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43	72340	6	0	0	0	0	To ensure consistency, chapter 6 authors should review chapter 30 and vice versa (UNITED STATES OF AMERICA)	Attended.
44	72341	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)	We restructured the chapter in order to improve readability. We reduced the overlap by setting up joint cross-chapter boxes.
45	72342	6	0	0	0	0	Whenever possible a quantitative likelihood scale should be used rather than the qualitative confidence scale. (UNITED STATES OF AMERICA)	We appreciate the comment. We have revised the use of calibrated language through the entire chapter. We agree that for biological observations often using confidence levels is more appropriate.
46	79033	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? (Joachim Rock, Johann Heinrich von Thuenen-Institute, Federal Research Institute for Rural Areas, Forestry and Fisheries)	We have revised the figure but this comment is not traceable with respect to numbers for size classes in the figures?
47	79444	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)	We have rewritten the chapter, and crosschecked with Chapter 30, we have set up cross-chapter boxes for better coordination.
48	80677	6	0	0	0	0	I strongly suggest to spell out "OA" as "ocean acidification". It provides a better reading experience. (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	While we implemented this recommendation here and there, the frequent use of the word ocean acidification made it necessary to also use the acronym.
49	80714	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 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). (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	we completely restructured sections combining parts of 6.2 and 6.3 to increase the flow during readability.
50	81036	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. (Monalisa Chatterjee, IPCC WGII TSU)	We have checked and updated the references and reference list.
51	82002	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. (Katharine Mach, IPCC WGII TSU)	We have rewritten and restructured the chapter, wrote the text to be more specific where needed and revised all figures thoroughly.
52	82003	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. (Katharine Mach, IPCC WGII TSU)	We have made links to chapters food security, health, polar regions and especially to chapters 5 and 30 to ensure that content is just discussed extensively once and otherwise referred to. We have referred to specific sections. The links to WGIII are based on the structure of the SOD of these chapters and has been rechecked.
53	82004	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. (Katharine Mach, IPCC WGII TSU)	We have made specific reference to sections of chapters in WGI and ensured consistency.

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54	82005	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. (Katharine Mach, IPCC WGII TSU)	Almost all of these recommendations have been implemented.
55	82006	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. (Katharine Mach, IPCC WGII TSU)	Almost all of these recommendations have been implemented.
56	82007	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. (Katharine Mach, IPCC WGII TSU)	We rewrote and edited chapter, tables, figures thoroughly, and now assure perfect referencing.
57	82008	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. (Katharine Mach, IPCC WGII TSU)	We included a timeline and risk assessment in the ES, and initiated and coordinated a cross-chapter marine risk table with a clear timeline.
58	82009	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. (Katharine Mach, IPCC WGII TSU)	We included a timeline and risk assessment in the ES, and initiated and coordinated a cross-chapter marine risk table with a clear timeline.
59	85071	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. (Michael Mastrandrea, IPCC WGII TSU)	We rewrote and edited chapter, tables, figures thoroughly.
60	85072	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? (Michael Mastrandrea, IPCC WGII TSU)	We rewrote and edited chapter, tables, figures thoroughly, also with TS and SPM in mind.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
61	65732	6	1	0	0	0	General Comment – Would a box on climate- overfishing interactions be worth using? (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We included a timeline and risk assessment in the ES, and initiated and coordinated a cross-chapter marine risk table with a clear timeline, including aspects of fisheries.
62	72343	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)	We will keep the title for chapter 6 as it is suitable for a sectoral chapter. There would be room for chapter 30 to emphasize its regional focus.
63	62493	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)	Our chapter focuses on the principles of climate change impacts across sectors and considered the relevant literature. Although we use regional examples, these should specifically be discussed in chapter 30 and in the regional chapter focussing on India. We have cited the paper by Naqvi et al. 2000 as an arly one addressing the issue of coastal hypoxia and nitrous formation.
64	58418	6	2	13	2	13	Why a ? (Martin Pecheux, Institut des Foraminifères Symbiotiques)	The header has been changed and there is no "?" anymore.
65	65733	6	3	0	0	0	General Comment – quite a bit of sloppy use of e.g. and i.e. throughout. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We have edited the chapter and use e.g. and i.e. as necessary.
66	59897	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)	We have spend considerable amount of effort trying to make the points clearer and highlight the most important conclusions of the assessment.
67	82010	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. (Katharine Mach, IPCC WGII TSU)	Timelines have been added in the ES and wording scrutinised to ensure that we are making clear if we are talking about past, present or future.
68	82011	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. (Katharine Mach, IPCC WGII TSU)	We revisesd the executive summary. Calibrated uncertainty language is now included where appropriate.
69	82012	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. (Katharine Mach, IPCC WGII TSU)	This has been taken care of in the context of the cross-chapter marine risk table.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
70	85073	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. (Michael Mastrandrea, IPCC WGII TSU)	This has been taken care of in the context of the cross-chapter marine risk table.
71	61092	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'. (European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)	This is now changed to "Virtually certain".
72	58876	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. (Svein Sundby, Institute of Marine Research)	Since the two paragraphs focus on two important points, one on ecosystem services and another on the abiotic/biotic properties of the ocean, it is better to separate them into two paragraphs rather than combining them into one.
73	72344	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)	We revised the Executive summary and wrote it to be more concise and precise. We agree on the different remits for chapter 6 and 30 and have coordinated as much as possible by generating cross-chapter products.
74	82013	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. (Katharine Mach, IPCC WGII TSU)	"Marine" is now added to the sentence.
75	56543	6	3	22	0	0	Remove "and" so that the sentence is "natural hazards, aesthetic, cultural..." (Archis Ambulkar, Brinjac Engineering Inc.)	"and" is now removed.
76	72345	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)	We have included the suggested reference.
77	58240	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 (Ricardo Anadon, University of Oviedo)	Agreed and implemented.
78	65734	6	3	27	3	27	delete "function" and insert "functioning" (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Word has been replaced as suggested.
79	82014	6	3	29	3	29	As a minor point, "have been" feels more appropriate here to me, rather than "were." (Katharine Mach, IPCC WGII TSU)	The word were has disappeared from the ES.
80	72346	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)	There is excellent evidence and mechanistic understanding that climate change, both natural and anthropogenic, influences marine ecosystems. The direction, amplitude and importance of individual drivers is less well understood and this is reflected by the range of confidence levels assigned within sections 6.1.2. and 6.3.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
81	57529	6	3	30	3	30	Please clarify " in early history", e.g. since last glacial... (Siyuan Ye, Qingdao institute of marine geology)	Millions of years added to avoid making the statement longer and more complicated by adding examples which are in the section
82	72347	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)	We have added a paragraph on DO events and their biological impact. There are very few marine records and these show mainly range extension and contraction similar to other examples, We like to emphasise that most events (and these might include DO events which happen over a few hundred of years in the ocean) though are slower and still had an impact which is the main point here. The fast rate of the DO events in the atmosphere of a few decades do not translate directly into the marine system.
83	82015	6	3	30	3	30	Is it possible to specify how much slower, in broad terms, this past change has been? (Katharine Mach, IPCC WGII TSU)	We have added numbers where possible in the section, naming each individual one would make the ES too heavy with detail.
84	72348	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)	Given the large number of evidence, we have to refer the reader to the section where details are provided.
85	65735	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. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	The example here refers to the geological record, historical and ongoing separated in text.
86	72349	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)	We will ensure that it is clearly stated that there are no extinctions yet related to climate change by separating the two time periods, We agree all extinctions are in the historical record.
87	72350	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)	We have corrected the sentence.
88	85074	6	3	36	3	46	Please provide line of sight for this paragraph. (Michael Mastrandrea, IPCC WGII TSU)	Attended, paragraph has changed.
89	82016	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? (Katharine Mach, IPCC WGII TSU)	We have corrected the sentence.
90	82017	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. (Katharine Mach, IPCC WGII TSU)	We have inserted a comparative statement for low and high latitude countries and hope that this has solved the issue.
91	59898	6	3	46	3	46	This paragraph needs to reference the relevant section in the chapter (square brackets) (AUSTRALIA)	We have included the reference to the corresponding section.
92	68888	6	3	46	3	46	Please add reference to (sub)sections where these statements find their basis. (NETHERLANDS)	We have included the reference to the corresponding section.
93	85075	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. (Michael Mastrandrea, IPCC WGII TSU)	Attended, the wording has changed .
94	65736	6	3	50	3	50	delete "e.g." (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We have deleted e.g.
95	82018	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. (Katharine Mach, IPCC WGII TSU)	Vulnerability to warming is now specified.
96	58877	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 (Svein Sundby, Institute of Marine Research)	Vulnerability to warming is now specified.
97	61093	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. (European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)	We think that high confidence would reflect the level of agreement and evidence on this statement. "high confidence"
98	65737	6	4	4	4	4	Insert "ultimately" "...(medium confidence). Ultimately temperature....." (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We have rewritten and edited the paragraph. "Ultimately" is not added because not needed.
99	65738	6	4	6	4	6	delete "e.g." (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	"e.g." deleted.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
100	65739	6	4	6	4	6	"... Tropical and other species..." (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	The text has been revised, suggestion does not apply any more.
101	58419	6	4	8	4	8	associated microalgae (Martin Pecheux, Institut des Foraminifères Symbiotiques)	The text has been revised, suggestion does not apply any more.
102	60748	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 (Xiaojin Zhu, National Climate Center)	In the ES and conclusion, we have adjusted the confidence statement of change in body size to medium confidence, which is now consistent with the assessment in the main text.
103	82019	6	4	13	4	18	For the statements on these lines, it would be preferable to specify the relevant general time frames. (Katharine Mach, IPCC WGII TSU)	We added "multidecadal time scales". Later in the ES we are more precise.
104	79445	6	4	14	4	13	It should read"average body size"...to be correct (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)	Adopted and revised.
105	85076	6	4	20	4	20	The relevance of section 6.5 is not clear, given that it is a section on projections. (Michael Mastrandrea, IPCC WGII TSU)	We have deleted the referenc to 6.5.
106	79446	6	4	22	4	25	This sentence (in bold) doesn't make sense grammatically (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)	This sentence is now revised.
107	72351	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)	For species shifts and richness we revised for high latitudes (high confidence) and tropical latitudes (medium confidence). For fisheries catch potential we revised for high latitudes (medium confidence) and tropical latitudes (low confidence). We have a cross-chapter box now on this with chapter 30.
108	82020	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? (Katharine Mach, IPCC WGII TSU)	This is now revised to "a global redistribution of catch potential".
109	65028	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 (George Hunt, University of Washington)	This is based on latitudinal average. There are regional differences even within the same latitudinal zones. The uncertainty of the projections is reflected in the low confidence on the magnitude of the projection.
110	63220	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. (Keith Brander, Technical University of Denmark)	Chapter 5 cited Sherman et al. (2009). The paper shows positive impacts of warming on Northern North Atlantic Large Marine Ecosystems. This is consistent with the statement in the ES. There is no contraction also with statement in Ch. 7. Our statement is on MAXIMUM CATCH POTENTIAL, while Ch. 7 suggests that REALIZED CATCH by fisheries would be affected by maximum catch potential, fisheries management and adaptability that are difficult to predict. The confidence on NPP has been revised and set to Medium. The confidence statement on fisheries catch potential is consistent with evidence and assessment provided in the main text. We also included a condition on changes in NPP regarding projected changes in fisheries catch potential. We made sure that the assessment is consistent across chapter.
111	82021	6	4	27	4	30	The approach taken here for communicating specific quantitative projections and confidence in them is very effective. (Katharine Mach, IPCC WGII TSU)	Thanks
112	59899	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)	We now refer to a corresponding level of warming which is applicable for the specific SRES scenario and the corresponding RCP.
113	56544	6	4	29	0	0	Term SRES is used at several locations in the chapter and needs to be defined here. (Archis Ambulkar, Brinjac Engineering Inc.)	The full form of SRES is now spelled out when first used.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
114	85077	6	4	30	4	30	The relevance of section 6.2.5 is not clear here. (Michael Mastrandrea, IPCC WGII TSU)	The section structure has been changed in the revised text and the references to different sections have been checked and revised.
115	61094	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. (European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)	We have revised the paragraph accordingly and are more precise with respect to how NPP is projected to be altered.
116	82022	6	4	33	4	33	For this reference to working group 1, the specific relevant chapter and/or sections should ideally be indicated. (Katharine Mach, IPCC WGII TSU)	The relevant chapters from WG1 are cited in the revised version of this chapter.
117	85078	6	4	33	4	33	Please specify the line of sight to Working Group I here. (Michael Mastrandrea, IPCC WGII TSU)	The relevant chapters from WG1 are cited in the revised version of this chapter.
118	72352	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)	These inconsistencies between the ocean chapters 6 and 30 have been resolved and cross-chapter products have been designed and implemented.
119	82023	6	4	38	4	38	In describing the types of microbes within parentheses here, would it be clearest to introduce the word phytoplankton here? (Katharine Mach, IPCC WGII TSU)	We now make a clearer distinction between microbes that are phototrophic, that is to say phytoplankton, and those that are not. However there is great overlap in nature because metabolic types are not unique, or fixed. We have tried to avoid confusion to the extent possible.
120	60749	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. (Xiaojin Zhu, National Climate Center)	The specific description is now "medium confidence" and is now consistent with the bold part pf the paragraph.
121	72353	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)	The specific description is now "medium confidence" and is now consistent with the bold part pf the paragraph.
122	79447	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)	We have rephrased and specified the text.
123	85079	6	4	47	4	47	The relevance of section 6.5 is not clear here. (Michael Mastrandrea, IPCC WGII TSU)	We have removed this reference.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
124	72354	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)	We disagree that this is a gross overstatement. The reviewer may not have grasped the message correctly as we refer to the diversity of biological responses? Furthermore, global ocean sections provide unequivocal evidence of the uptake of anthropogenic CO2 into the surface ocean and its gradual penetration to depth (Doney 2006 Scientific American). As anthropogenic emissions continue to increase, the ocean takes up more anthropogenic CO2 each year.
125	79953	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)	Fishes are now explicitly mentioned.
126	72355	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)	We concur and have altered this text to read. "Most plants and microalgae respond positively to elevated CO2 levels by increasing photosynthesis and growth (high confidence). "
127	72356	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)	Agreed, but this information is provided in the Exec Summary under the context of rising CO2. The effects of other environmental drivers on plants are addressd in detail in the chapter.
128	56269	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 pCO2 and decreased [CO32-], CaCO3 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 CO2. 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 CO2 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. (Elizabeth Mcleod, The Nature Conservancy)	There are a number of studies which reveal that ocean acidification has no significant effect on some calcifiers (e.g. Langer et al., 2006, 2009). There is also limited evidence to make strong statements on how OA might alter ecosystem level biogeochemical processes.
129	82024	6	5	2	5	2	It would be clearest to specify which type of change meant here--"projected ocean acidification" might be preferable. (Katharine Mach, IPCC WGII TSU)	The whole paragraph is on ocean acification, we have made sure this is very clear.
130	80670	6	5	3	0	0	A link could be made to Box CC-OA (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	A link has been added here.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
131	80671	6	5	3	0	0	remain POORLY explored (because there is limited information on phytoplankton) (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	Amended to "largely unexplored".
132	59900	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)	The assignment of confidence statement has been checked and revised where needed.
133	72357	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)	This confidence statement has been removed.
134	82025	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. (Katharine Mach, IPCC WGII TSU)	The assignment of confidence statements has been revised.
135	80672	6	5	5	0	0	I do not think that 30% increase in ocean acidity since preindustrial time is "limited" (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	The sentence has been rephrased to emphasise that the statement was about field observations of biotic responses attributed to anthropogenic ocean acidification and the background of natural variability which in many places is larger than the anthropogenic OA.
136	56270	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 century for the global oceans (Elizabeth Mcleod, The Nature Conservancy)	The sentence has been rephrased to emphasise that the statement was about field observations of biotic responses attributed to anthropogenic ocean acidification and the background of natural variability which in many places is larger than the anthropogenic OA.
137	82026	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.? (Katharine Mach, IPCC WGII TSU)	The sentence has been rephrased to emphasise that the statement was about field observations of biotic responses attributed to anthropogenic ocean acidification and the background of natural variability which in many places is larger than the anthropogenic OA.
138	72358	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)	The sentence has been rephrased to emphasise that the statement was about field observations of biotic responses attributed to anthropogenic ocean acidification and the background of natural variability which in many places is larger than the anthropogenic OA.
139	72359	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)	This point has been added to the main text and conclusions section as there is not enough space for this level of detail in the ES.
140	72360	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)	This text has been modified.
141	80673	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. (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	While there are several definitions of reef e.g. a reef is a structure made by organisms growing on top of each other and can be made by a wide range of organisms. As this seems like a contentious issue we agree to use the term communities once warm- and cold water corals are compared.
142	80674	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.) (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	This sentence has been deleted, the reference has been considered in the section on cold-water corals.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
143	72361	6	5	15	5	19	Food availability is also an environmental driver that should be discussed in the text. (UNITED STATES OF AMERICA)	The paragraph refers to physicochemical environmental drivers, food availability is considered elsewhere.
144	82027	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. (Katharine Mach, IPCC WGII TSU)	Agreed, attended by modifying this to deal only with physiological responses to physicochemical drivers
145	56271	6	5	16	0	0	not sure you can say "physiological knowledge projects" - could you instead say "current research suggests..." (Elizabeth Mcleod, The Nature Conservancy)	Sentence deleted for clarity (following com 146).
146	65740	6	5	16	5	16	Delete "For example, physiological knowledge projects that" This edit may make this statement clearer. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Agreed, attended.
147	65741	6	5	17	5	17	"...hypoxia act to narrow thermal..." (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Agreed, attended.
148	80675	6	5	19	0	0	Replace "warm water corals" by "reef-building corals" (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	Agreed, attended.
149	61095	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) (European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)	We feel that the Executive Summary should contain general qualitative statements rather than quantitative details. The quantitative definitions of hypoxia are given in the respective section of the main text. No action taken.
150	85080	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. (Michael Mastrandrea, IPCC WGII TSU)	Good catch, thank you. Corrected to "medium confidence".
151	82028	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. (Katharine Mach, IPCC WGII TSU)	The time frame was specified and statement clarifying the relation with the climate change was added.
152	72362	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)	Sentence rephrased. Confidence level reduced to medium.
153	60750	6	5	30	5	32	Content and above paragraph (21-18) belong to the same theme, the proposal to merge. (Xiaojin Zhu, National Climate Center)	Paragraphs merged and rephrased.
154	61096	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).. (European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)	Done - see above.
155	65742	6	5	30	5	32	delete " but in addition to hypoxia effects" Insert at the end of line 32 "other than effects of hypoxia" (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	This bullet has been completely rephrased.
156	72363	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)	This bullet has been completely rephrased.
157	82029	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. (Katharine Mach, IPCC WGII TSU)	This bullet has been completely rephrased.
158	85081	6	5	30	5	32	Section 6.3.5 also appears to provide relevant information. (Michael Mastrandrea, IPCC WGII TSU)	This bullet has been completely rephrased, references checked..

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
159	59901	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)	We now provide the following examples: nutrient fertilization, binding of CO2 by enhanced alkalinity, or direct CO2 injection into the deep ocean. We disagree that this phrase on SRM is unclear.
160	63512	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)	There is insufficient space in the Executive Summary to add this additional detail.
161	68889	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 than 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)	We disagree, direct CO2 injection into deep water was been widely discussed within the context of CDR geoengineering.
162	56272	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 (Elizabeth Mcleod, The Nature Conservancy)	This sentence has been amended.
163	65065	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). (Action Group on Erosion, Technology and Concentration (ETC Group))	there is insufficient space in the Exec. Summary to point out this nuance.
164	72364	6	5	37	5	37	The authors should delete the word "Alternative." (UNITED STATES OF AMERICA)	We prefer to retain this word - as discussion on geoengineering methods has to date focussed on 2 alternatives SRM and CDR.
165	57494	6	5	37	5	38	See the comment to (Chapter 5, Page 50, Lines 26-28) (Alexey Ryaboshapko, Institute of Global Climate and Ecology)	The text in Chapter 5 reflects the text we have written in CH6.
166	79954	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)	We prefer to retain the word Alternative (see our response to comment 164). Sudden cessation of SRM is too detailed for the Exec summary.
167	79955	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)	There is insufficient space in the Executive Summary to highlight this suggested topic.
168	58878	6	5	43	5	44	If the atmosphere is included in the biosphere 95% is not correct (Svein Sundby, Institute of Marine Research)	We rephrased the text and clarified this issue.
169	82030	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"? (Katharine Mach, IPCC WGII TSU)	We rephrased the text and clarified this issue.
170	56273	6	5	44	0	0	marine habitats exhibit natural variability on BOTH temporal and spatial scales (Elizabeth Mcleod, The Nature Conservancy)	Agreed, and this is a point we make repeatedly later in the detailed sections of the chapter.
171	82031	6	5	45	5	45	"Synoptic" could be considered jargon that would be preferable to avoid in an opening statement. (Katharine Mach, IPCC WGII TSU)	The word has been deleted.
172	72365	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)	This text has been deleted in subsequent iterations of Ch. 6.
173	65743	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" (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Deleted.
174	58879	6	5	49	5	49	add: "turbulent mixing" after upper ocean stratification (Svein Sundby, Institute of Marine Research)	This text is no longer present, and so adding this phrase is no longer relevant.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
175	65744	6	5	51	5	51	Functioning is better than function. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Amended.
176	80385	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. (Gian-Kasper Plattner, IPCC WGI TSU)	We have now referred widely to WGI assesment of the physical sciences.
177	82032	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. (Katharine Mach, IPCC WGII TSU)	Rephrased to "Much more than in previous IPCC reports" and reference to Fig 1.2.
178	64850	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. (Naomi Harada, Japan Agency for Marine-Earth Science and Technology)	This is too detailed for our coverage of the pro's and con's of satellite oceanography to provide high resolution estimates of phytoplankton stocks and NPP for the ocean science community.
179	72366	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)	We have rewritten the point of departure to explain the developments fromAR4 to AR5 better.
180	72367	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)	Our chapter deals with open ocean (pelagic) systems and does not focus on coastal marine habitats.
181	62494	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)	The regional aspects are covered by Chapter 30. We are laying out more clearly at the beginning of this chapter now which content can be found in which chapter.
182	65745	6	6	8	6	8	Delete "scale which " and insert "that" to give "...ecosystem that is required..." (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Amended.
183	82033	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. (Katharine Mach, IPCC WGII TSU)	Now cross-referenced in a cross chapter box on NPP.
184	72368	6	6	14	6	14	Body size decrease is not mentioned in paragraph and should be considered for inclusion. (UNITED STATES OF AMERICA)	We appreciate that body size is important but not to be mentioned in this general introduction. Later in the text we include this aspect in our discussions, e.g. of foodwebs. (This comment seems to be meant for page 16, line 14)
185	82034	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. (Katharine Mach, IPCC WGII TSU)	Agreed and amended.
186	58880	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". (Svein Sundby, Institute of Marine Research)	We mostly use variable now.
187	80676	6	6	16	6	19	The right unit for atmospheric CO2 is a concentration unit (ppm or ppmv) (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	Gases is air can be given as both partial pressure or as fractional values. This is a long standing convention in physics and physiology. (This comment seems to be meant for page 7, line 16)
188	57095	6	6	19	6	19	2100.-On -> 2100. On (Alexey V. Eliseev, A.M.Obukhov Institute of Atmospheric Physics, Russian Academy of Sciences)	This comment is unclear but seems to just address a typo. (This comment seems to be meant for page 7, line 16)
189	72369	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)	Unclear which section this refers to.
190	57207	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." (Erica Head, Fisheries and Oceans Canada)	This figure has subsequently been removed and replaced with a global NPP figure in the cross chapter box on NPP.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
191	80678	6	6	30	0	0	"The rate of ocean acidification in surface waters presently..." (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	Added "in surface waters". (This comment seems to be meant for page 7, line 30)
192	80679	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). (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	When discussing general changes in pH adding a scale would just disturb the flow and is not necessary. When we mention specific pH values, we ensured that the scale is added. (This comment seems to be meant for page 7, line 31)
193	82035	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. (Katharine Mach, IPCC WGII TSU)	WGI references have been added as appropriate.
194	58881	6	6	32	6	32	"variable" (Svein Sundby, Institute of Marine Research)	Agreed and amended.
195	58529	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. (Janice Lough, Australian Institute of Marine Science)	This reference has been added.
196	61097	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). (European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)	References to specific Sections of WGI and reference to Sen Gupta and McNeil (2012) added.
197	61098	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. (European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)	In the revised draft, reference to Ch.30 is given, and efforts are made to demonstrate consistency between the chapters.
198	72370	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)	This appears to be a misplaced comment, and thus we cannot address it further.
199	65746	6	6	33	6	34	Insert "in" and delete "on e.g." to give "...variability in temperature..." (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Agreed and amended.
200	65747	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? (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	The entire paragraph was rephrased.
201	72371	6	6	33	6	34	One sentence paragraph? Also, this sentence doesn't mention hypoxia which is a section. (UNITED STATES OF AMERICA)	Agreed and amended.
202	72372	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)	We agree with this. The concept of linking global warming to ENSO cannot be properly discussed here. The sentences referring to ENSO as well as the specific temporal scales of the variability were removed from the text.
203	56545	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. (Archis Ambulkar, Brinjac Engineering Inc.)	See above
204	58882	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. (Svein Sundby, Institute of Marine Research)	See above
205	72373	6	6	44	6	44	There should be mention of seasonal (and higher frequency) variability, e.g. due to storms (UNITED STATES OF AMERICA)	See above
206	58530	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. (Janice Lough, Australian Institute of Marine Science)	This is correct and has now been mentioned, reference included.
207	57208	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" (Erica Head, Fisheries and Oceans Canada)	The sentence has been re-phrased, "annual mean" added.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
208	57209	6	7	4	7	4	Please add the word "annual" as suggested. "difference between the maximum and minimum annual values for each grid etc." (Erica Head, Fisheries and Oceans Canada)	The sentence has been re-phrased, "annual mean" added.
209	72374	6	7	4	7	7	This sentence is incomprehensible. Please reword to clarify meaning. (UNITED STATES OF AMERICA)	The sentence has been re-phrased.
210	72375	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)	We disagree. Expressing CO2 content as a partial pressure is common practice.
211	72376	6	7	17	7	17	Sentence ending in "...and following several RCPs" is not clear. Please reword the sentence. (UNITED STATES OF AMERICA)	Reworded
212	82036	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. (Katharine Mach, IPCC WGII TSU)	This is indeed so - the former numbers give approximate qualitative estimate, while the latter result from quantitative modeling. We added "about" before the estimated numbers to emphasize their approximate character and avoid confusion.
213	56546	6	7	19	0	0	"-" needs to be removed between sentences i.e. "2100." and "On average..." (Archis Ambulkar, Brinjac Engineering Inc.)	Text has been rewritten and edited.
214	65748	6	7	19	7	19	delete hyphen (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Text has been rewritten and edited.
215	72377	6	7	20	7	20	Replace "drawdown" with "uptake." (UNITED STATES OF AMERICA)	Replaced
216	65749	6	7	21	7	21	Delete "an increase in acidity measured as a" insert "due to" to give "... ocean acidification (OA), due to decline..." (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	sentence has been rephrased.
217	72378	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)	Sentence has been rephrased.
218	72379	6	7	25	7	27	This sentence should be supported with references for the reported natural variability. (UNITED STATES OF AMERICA)	Reference to WG1 Ch3 is added.
219	62495	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)	We agree and are mentioning this gap but this will be done in other documents. While undoubtedly important, such technical recommendations are probably beyond the scope of AR5.
220	72380	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)	We agree and have revised.
221	72381	6	7	32	7	32	There are no "pH units". Remove the words "pH units". (UNITED STATES OF AMERICA)	We use the term pH unit in the sense of its numerical value. In the revised version, we avoid using the term unless necessary for clarity.
222	72382	6	7	35	7	36	Please explain why / how salinity reduction exacerbates OA. (UNITED STATES OF AMERICA)	We added that dilution of carbonate system parameters contributes to acidification.
223	58420	6	7	37	7	39	...will take tens of thousand years for neutralisation and hundreds of thousand years... (neutrlisation require several turnover of a 1500 cycle, and weathering is on 200-500 000 years time scale) (Martin Pecheux, Institut des Foraminifères Symbiotiques)	We cannot change our wording. The reviewer has not provided evidence or reference.
224	72383	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)	According to the standard adopted throughout the AR5, gases should be given in μatm .
225	65750	6	7	50	7	50	What does synoptic mean? Not a common usage? (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Word lost during revisions
226	65751	6	8	2	8	2	Give % surface area? (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We converted everything into % volume to simplify.
227	72384	6	8	2	8	2	"0.5 ml L-1" should be converted to mg/L. (UNITED STATES OF AMERICA)	We provide thresholds in μmol and volumes in % to simplify.
228	72385	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)	We provide thresholds in μmol and volumes in % to simplify.
229	62496	6	8	3	8	3	Section 6.1.1.3: replace word 'basis' by 'basin' (INDIA)	Agreed and amended. (This comment seems to be meant for page 8, line 8)
230	57210	6	8	8	8	8	Replace "basis" with "basins" (Erica Head, Fisheries and Oceans Canada)	Agreed and amended.
231	59902	6	8	8	8	8	Basis' should read 'basins' (AUSTRALIA)	Agreed and amended.
232	72386	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)	Text has been rephrased.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
233	82037	6	8	9	8	10	Is this described decrease in oxygen an average value for oxygen minimum zones or mid-waters? (Katharine Mach, IPCC WGII TSU)	We provide thresholds in umol and volumes in % to simplify.
234	61099	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. (European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)	These details can be found in the paper by Keeling et al. In our opinion, it is not necessary to display them here.
235	61100	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. (European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)	This statement is well taken. The text has been heavily revised. We have separated the discussion of the coastal ocean and its hypoxia issues (see also Figure 11). In depth discussion is to be found in WGI ch. 6 and WGII chapter 5.
236	59903	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)	Metazoans replaced with animal life. Sentence rephrased.
237	72387	6	8	13	8	14	The "excluding metazoans" within this sentence is confusing. Please correct or clarify this sentence. (UNITED STATES OF AMERICA)	Metazoans replaced with animal life. Sentence rephrased.
238	65752	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. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We have removed the Aral and Black Seas. The Black Sea is only dealt with for comparative reasons later. This sea is in the remit of the regional ocean chapter.
239	57211	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." (Erica Head, Fisheries and Oceans Canada)	We fully agree, the phrase is cut short.
240	57212	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. (Erica Head, Fisheries and Oceans Canada)	We fully agree, the phrase is cut short.
241	80386	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. (Gian-Kasper Plattner, IPCC WGI TSU)	We have replaced "very likely" by "likely", rephrased and included a reference to WGI Ch6.
242	72388	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)	We have rephrased with a focus on precipitation and added a reference under temperature and salinity.
243	72389	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)	This section has been revised and shortened.
244	72390	6	8	26	8	28	The likelihood of methane hydrate destabilization should be discussed somewhere in chapter 6. (UNITED STATES OF AMERICA)	As stated in the text, this topic is largely underexplored, and there is little we can add to the chapter on this matter. We consider this a WGI issue, but mention it here for completeness.
245	65753	6	8	27	8	27	replace "exacerbating" with exacerbate (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Agreed and amended.
246	80387	6	8	31	8	41	Please consider to also cross-reference WGI AR5 in this section. (Gian-Kasper Plattner, IPCC WGI TSU)	Cross-references were added.
247	65754	6	8	33	8	33	Delete "Most experiments" to give "Modeling indicates that..." (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	The word "MOST" is essential here, because not ALL experiments agree on this matter. Slightly revised pointing to models and their differences.
248	61101	6	8	33	8	34	Important to include reference recent work which looks at mixed layer changes in the CMIP5 models here. Specifically Sallee 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). (European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)	Reference added, thank you.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
249	65755	6	8	33	8	34	Will not stormier seas deepen the mixing layer? (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Yes, this is another possible feedback of the opposite sign, but still - there is little we can add to what is stated in the text, namely: "Most models project that the depth of the surface mixed layer will become shallower in the coming decades". No action taken.
250	72391	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)	This section was rephrased to clarify the regions where nutrient limitations would occur, and also the processes that might compensate.
251	65756	6	8	46	8	46	Delete "driver e.g." to give "... regimes of rising..." (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	This would change the meaning of the sentence. We prefer to keep it as is.
252	61102	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. (European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)	Isn't it already there? See, for example, paragraph 1 and 2 of the present ES.
253	82038	6	8	46	8	47	The chapter team could consider placing "virtually certain" within parentheses at the end of the sentence. (Katharine Mach, IPCC WGII TSU)	The conclusions section was dropped and the statement moved to ES where virtually certain is now placed at the end.
254	72392	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)	It is our firm opinion that yes - it is virtually certain, and this is perhaps the central message of the chapter, which also agrees with the WG1 projections for the ocean system exposure to climate-related stressors.
255	65757	6	8	47	8	47	change to say "...surface layers will very likely enhance and prolong stratification, thereby limiting the nutrients available..." (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	The sentence was re-phrased.
256	65758	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. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	No - enhanced stratification will surely reduce mixing, thus leading to shallower mixed layer, at least initially. with further warming the thermocline would sink. This is now mentioned.
257	58421	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 (Martin Pecheux, Institut des Foraminifères Symbiotiques)	See next comment 258 and answer.
258	59904	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)	What we are talking about here is quite simple: because the mixed layer becomes shallower, the phytoplankton whose biomass is distributed within the mixed layer stays closer to the surface and hence receives more light. This simple notion probably does not require any special discussion in the body of the chapter or references.
259	61934	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. (Dag Lorents Aksnes, University of Bergen)	See previous comment 258 and answer.
260	65759	6	8	51	8	51	"increase due to shoaling of the surface mixed later becoming shallower." (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	shoaling = becoming shallower, isn't it? No action taken.
261	72402	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)	We have restructured the chapter, and assure now the correct numbering. (This comment seems to be meant for page 9, line 8)
262	72403	6	9	0	0	0	Figure 6-3: There is no reference to figure 6-3 in the text. (UNITED STATES OF AMERICA)	Some figures have been exchanged, appropriate references have been added.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
263	72393	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)	range shifts are more clearly emphasised now, we have included range shifts, expansions, contractions, and extinctions, emergences, changing abundances of species.
264	65760	6	9	6	9	6	Change to "... forcings to which organisms are responding." (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Rephrased accordingly.
265	57213	6	9	8	9	8	I think "Figure 6-11" should be "Figure 6-3". (Erica Head, Fisheries and Oceans Canada)	Some figures have been exchanged, appropriate references have been added.
266	65761	6	9	10	9	11	Delete " of the last centuries" to give "...data sets from organisms..." (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Rephrased accordingly.
267	79448	6	9	11	9	11	Insert "for example slow-growing bivalve molluscs or corals". (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)	We did not include these examples in the text. However, we refer to fig 6-3 which shows examples of affected species.
268	72394	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)	While we agree that sediment records allow assessing the mentioned examples linking the biotic change to one single driver from the marine records has been proven difficult . We added the word "biological" to make this clearer.
269	59905	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)	Rephrased accordingly.
270	79449	6	9	15	9	17	This sentence (starting "Importantly though...") doesn't make sense grammatically (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)	Rephrased accordingly.
271	65029	6	9	17	0	19	last part does not follow bad sentence (George Hunt, University of Washington)	Paragraph has been rephrased.
272	80388	6	9	18	9	18	Please provide a specific refrence to WGI, e.g. WGI Ch5. (Gian-Kasper Plattner, IPCC WGI TSU)	We specified the references to WGI, Ch3 and Ch5.3
273	65762	6	9	19	9	19	Insert " from" to give "... record and from global circulation..." (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Reworded the sentence to clarify.
274	65763	6	9	20	9	20	replace "inform" with "forecast" (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Rephrased accordingly.
275	79450	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)	Figure changed to simplify and show temporal relationships, drivers discussed in the text.
276	58422	6	9	25	9	26	Fig 6-3. Legend, add: Note different time scale by a factor of 1500 (Martin Pecheux, Institut des Foraminifères Symbiotiques)	Content of figure and caption revised for clarity.
277	58423	6	9	27	9	27	...model output, only indicative (Martin Pecheux, Institut des Foraminifères Symbiotiques)	Content of figure and caption revised for clarity.
278	58531	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 signifcance of the overall findings. (Janice Lough, Australian Institute of Marine Science)	The new data has been incorporated into the figure.
279	72395	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)	Changed to century.
280	61103	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. (European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)	The paper and its finding has been included.
281	72396	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)	Numbers for regional differences have been added.
282	65764	6	9	39	9	40	delete "'s ocean" to give "... rich than today's ocean." (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Not clear what this refers to as this is how it is written.
283	82039	6	9	40	9	40	The chapter team could consider placing "high confidence" within parentheses at the end of the sentence. (Katharine Mach, IPCC WGII TSU)	Changed throughout the chapter text.
284	72397	6	9	40	9	42	Please stipulate planktic foraminifera. Reword the sentence as the B/A event is acturally a part of the entire deglacial transition. The way it is worded sounds likthe deglacial is separate from the B/A. As in prior comment, equatorward expansion occurs during interglacial to glacial transitions (UNITED STATES OF AMERICA)	Content of figure and caption revised for clarity. The sentence starts with Marine plankton such as foraminifer, using planktic foraminifers would be redundant B/A rephrased, expansion occurs in a change from a glacial to an interglacial ie with warming in these species.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
285	70556	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. (AKIHIKO MURATA, Japan Agency for Marine-Earth Science and Technology)	Indeed, but the focus of this paragraph are the biotic reactions not the carbon cycle feedbacks which are firstly minor and secondly discussed in WGI CH6.
286	72398	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)	Rephrased and streamlined such that these regional examples were lost.
287	58424	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 (Martin Pecheux, Institut des Foraminifères Symbiotiques)	While highly desirable not every statement can be referenced to as otherwise the reference list would get out of order.
288	64851	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. (Naomi Harada, Japan Agency for Marine-Earth Science and Technology)	Rephrased and streamlined such that these regional examples were lost.
289	65765	6	9	49	9	49	delete "today's" and replace with "that of today" (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Rephrased accordingly.
290	72399	6	9	49	9	54	What was change in aragonite saturation state during the Pliocene warm period? (UNITED STATES OF AMERICA)	To our knoweldge no carbon cycle model has been run for this time interval and hence we do not know. There is no evidence suggesting that it was strongly different from today based on the pH evidence, and the realtively minor changes in Ca compared to today, but we do not know.
291	72400	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)	Content of figure and caption revised for clarity. Otherwise, there is no space to expand this paragraph. As this time interval is also a chosen interval in WGI it would be an omission not to spell out the biotic response, especially due to the good understanding of the environmental parameters. There have been a number of studies now, all confirming similar CO2 with different methodologies therefore providing confidence in the assessment. We have rewritten the paragraph to clarify the issues suggested by the reviewers. Studies of Pliocene climate are in WGI and not touched on here. Both spellings planktic and planktonic are in the literature with ongoing debate is the word has a latin or greek origin.
292	72401	6	9	50	9	50	microatm do not equal ppm. Suggest removing "= ppm". (UNITED STATES OF AMERICA)	Rephrased accordingly.
293	82040	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. (Katharine Mach, IPCC WGII TSU)	This is not a warming trend but a warm interval, we have clarified this in the text.
294	65766	6	9	53	9	54	Delete " However no" to give "... (high confidence). Increases in species...." (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Rephrased accordingly.
295	65767	6	9	54	9	54	replace "has" with "have" (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We have rephrased the sentence.
296	56547	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. (Archis Ambulkar, Brinjac Engineering Inc.)	This is the first time in the text, the former is a figure caption which might move depending on layout.
297	58425	6	10	4	1	4	...future ocean, apart the extreme Cretaceous/Tertiary boundary, is the... (Martin Pecheux, Institut des Foraminifères Symbiotiques)	The complexity of a meteorite impact makes it a difficult analogue for future climate change.
298	72404	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)	Sentence rewritten, rates added.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
299	65768	6	10	4	10	21	General comment – some very long sentences needing to be split up for clarify meaning. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Revised accordingly.
300	58426	6	10	5	10	5	PETM...an event of rapid warming (in 10-20 000 years) (Martin Pecheux, Institut des Foraminifères Symbiotiques)	We have now given the duration (millennia).
301	65769	6	10	5	10	5	Grammar check to give "... acidification. Although model..." (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Request adopted during rewrite for clarity.
302	58427	6	10	6	1	6	10-100 time higher (Martin Pecheux, Institut des Foraminifères Symbiotiques)	Text revised for clarity in line with present knowledge.
303	82041	6	10	8	10	8	Presumably this model projection was for change during the PETM? It could be helpful to clarify this. (Katharine Mach, IPCC WGII TSU)	Rephrased to clarify.
304	59906	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)	Indeed the starting pH was lower, rewritten to clarify.
305	65770	6	10	12	10	12	"... (6.2.2.-3). There..." new sentence (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Rephrased to clarify.
306	65771	6	10	13	10	14	Change to "In contrast, in the benthic ecosystem a 50% extinction among benthic foraminifera was recorded..." (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Rephrased to clarify.
307	65772	6	10	13	10	14	General comment – an ecosystem does not record on extinction. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We disagree, with a change of the expression.
308	58749	6	10	17	10	17	delete "larger". Foraminifera are no larger than the algae and corals (Connie Lovejoy, Université Laval)	We disagree, larger foraminifer is a standard expression, changed to clarify.
309	79451	6	10	18	10	20	What are the lessons we take from this historical information? (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)	We have decided to have one summary at the end of each paragraph to enhance the flow of the writing and to be able to draw more wider arching results, we tried to make the lesson clearer in the text.
310	72405	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)	While we would love to expand the section, there is not enough space.
311	65773	6	10	26	10	27	insert comma after "radiolarian)," (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We have rephrased the sentence.
312	65774	6	10	27	10	27	change parenthesis to "(e.g. coccolithophores, maximum 7%, Leckie et al., 2002)" (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We have rephrased the text.
313	65775	6	10	31	10	31	Change first sentence to say "For examples of collapse of marine ecosystems at global scale, delving into..." (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Sentences changed.
314	65776	6	10	35	10	35	Change "though" to "Although" to give "...depletion. Although the rate of..." (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We have rephrased the sentence.
315	58428	6	10	37	10	37	(Wood, 1999 Wood R, 1999, Reef evolution. Oxford Univ Press, UK, 254pp (Martin Pecheux, Institut des Foraminifères Symbiotiques)	We are citing a more recent compilation of the effects of the environmental change at the PT on reefs in the text. However, we cite it later in the chapter.
316	57214	6	10	42	10	43	only the deep time" older that 33 Ma" - what is "deep time"? I don't know! (Erica Head, Fisheries and Oceans Canada)	We have removed "deep time".
317	82042	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. (Katharine Mach, IPCC WGII TSU)	Values given to facilitate discussion.
318	72406	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)	Reference to the discussion in WGI given.
319	80680	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. (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	The relevant aspects are mentioned in the PETM part of this section, except for the interpretation.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
320	59907	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)	We have rephrased the sentence.
321	72407	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)	Changed and reworded.
322	58429	6	10	48	10	48	...Earth history (apart the asteroidal Cretaceous/Tertiary event). (Martin Pecheux, Institut des Foraminifères Symbiotiques)	We have two different confidence levels for the time before 65 and after to reflect this possibility.
323	65777	6	10	48	10	48	delete "modern" replace with contemporary or current? (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Rephrased accordingly.
324	65778	6	10	48	10	48	insert "unprecedented" to give "...acidification unprecedented in at least..." (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We have rephrased the sentence.
325	72408	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)	We have added high confidence, to avoid the impression of certainty while balancing the evidence, Your own assessment of highly unlikely would result in high confidence.
326	65779	6	10	52	10	52	Edit to say "...climate change is compared to the ..." (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We have reworded the sentence.
327	65780	6	10	54	10	54	insert "many" to say "...many marine organisms" (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We say "many organisms living in today's oceans". Including marine would be a repetition.
328	72409	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)	The section has been shortened to highlight the lessons learned from the time series, the information has been merged in a section on historical and paleontological records.
329	58532	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. (Janice Lough, Australian Institute of Marine Science)	The section has been shortened to emphasize this point.
330	72410	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)	The section has been refocused to briefly discuss time series of environmental data from time series with biotic data.
331	58430	6	11	6	11	6	...tree rings, coral bands, (Martin Pecheux, Institut des Foraminifères Symbiotiques)	The sentence has been deleted to shorten the section.
332	82043	6	11	6	11	6	It seems that "long-term" data sets are meant here, which could be clarified. (Katharine Mach, IPCC WGII TSU)	Reworded into multi-decadal.
333	59908	6	11	10	11	11	The sentence beginning 'The undersampling...' could be more specific - what specifically can we not make 'meaningful assessments' about? (AUSTRALIA)	Linked to example to clarify.
334	79452	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)	We have deleted this table, comment does not apply any more.
335	65781	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. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We have had to cut the table due to page constraints and now only use three different examples one for each of the main groups of information, therefore additional reference cannot be accommodated.
336	72411	6	11	22	11	22	Please explain what is meant by "counter-rotating". (UNITED STATES OF AMERICA)	Figure has been deleted
337	59909	6	11	25	11	29	Length of sentence makes it difficult to understand. Consider re-phrasing. (AUSTRALIA)	Sentence has been rewritten to make it clearer

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
338	58504	6	11	27	11	27	"the North Atlantic Oscillation Index [NAOI]" should be revised by "the North Atlantic Oscillation Index [NAOI]" (lin mou, State Oceanic Administration of China, National Marine Data and Information Service)	We follow the same classification as WGI, CHAPTER 3 Ocean observations
339	79453	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)	The figure has been deleted.
340	57215	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. (Erica Head, Fisheries and Oceans Canada)	The figure has been deleted.
341	58533	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. (Janice Lough, Australian Institute of Marine Science)	The figure has been deleted.
342	58431	6	11	40	11	40	in figure, negative PP in blue ! (Martin Pecheux, Institut des Foraminifères Symbiotiques)	The figure has been deleted.
343	58241	6	11	48	0	0	I suggest to introduce a very productive RADIALES project a Long-Term study in the Iberian Peninsula, 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, Vallergera, S, Pinardi, N, Behrens, H.W.A, Manzella, G, Prandle, D, Stel, J.H. (Ed.) Elsevier Science, 99-105] (Ricardo Anadon, University of Oviedo)	Thank you for the suggestion, we cannot aim for completeness in this section and have selected a few examples to show the geographic spread of these stations.
344	70557	6	11	49	0	0	"northwest of Hokkaido" is wrong. "east of Hokkaido" (AKIHIKO MURATA, Japan Agency for Marine-Earth Science and Technology)	Corrected, but section has been shortened and rephrased.
345	79454	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)	Thank you for the suggestion, we cannot aim for completeness in this section and have selected a few examples to show the geographic spread of these stations.
346	80681	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. (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	The sentence has been deleted to shorten the section.
347	79455	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)	It has been included.
348	59910	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)	The paragraph has been restructured to highlight the issue of length of time series stations.
349	65612	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. (Sukgeun Jung, Jeju National University)	We agree and have focussed the section on the important point of length of time series with regards to natural variability.
350	61104	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. (European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)	We have included this paper as it quantifies the years needed for reliable conclusions from satellite series.
351	72412	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)	The whole chapter has been restructured and sections are now leading from principles to ecosystem impacts. This should be clearer to follow.
352	72413	6	12	21	12	41	Please consider whether this section is too general and really off the chapter's topic. (UNITED STATES OF AMERICA)	This section has been restructured and shortened to remove extraneous material.
353	56274	6	12	30	0	0	a key issues is IF and how quickly organisms can adapt (Elizabeth Mcleod, The Nature Conservancy)	Agreed and complemented.
354	72414	6	12	33	12	34	Please add a citation and more detail regarding which fish and bacteria are well studied. (UNITED STATES OF AMERICA)	This discussion has been deleted from the final draft.
355	72415	6	12	40	12	41	Is the lack of evidence for adaptation in marine, terrestrial environments, or both? (UNITED STATES OF AMERICA)	This discussion has been deleted from the final draft.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
356	79456	6	12	43	12	46	Can't quite see what this table (Table 6-2) adds (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)	This table has been deleted, comment does not apply any more.
357	79457	6	12	48	12	51	Sentence a bit difficult to follow. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)	This discussion has been deleted from the final draft.
358	65030	6	13	4	0	5	Here is a case where the assumption must be that the reader is clueless. (George Hunt, University of Washington)	We have simplified this text.
359	57216	6	13	5	13	5	Should have and extra bracket, thus (CO2, nitrate, phosphate, silicate) (Erica Head, Fisheries and Oceans Canada)	corrected
360	56548	6	13	5	13	6	")" needs to be added, probably after "iron" i.e. "(CO2, nitrate...including iron)" (Archis Ambulkar, Brinjac Engineering Inc.)	corrected
361	58750	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. (Connie Lovejoy, Université Laval)	We have now emphasized the density stratification as the key issue in various sections.
362	58242	6	13	7	0	0	Change Taboada by Gonzalez-Taboada in the reference. (Ricardo Anadon, University of Oviedo)	We have corrected the Author name González-Taboada.
363	58432	6	13	12	13	12	net upxelling (equatorial, coastal) (Martin Pecheux, Institut des Foraminifères Symbiotiques)	Section has been heavily rephrased such that this formulation has been lost.
364	58883	6	13	13	13	13	Frontal dynamics and eddies are also causing considerable vertical transport across the photic zone (Svein Sundby, Institute of Marine Research)	Section has been heavily rephrased such that this formulation has been lost.
365	72416	6	13	13	13	13	The authors should mention the important role of eddies in nutrient supply. (UNITED STATES OF AMERICA)	Section has been heavily rephrased such that this formulation has been lost.
366	59911	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)	The sentence content is actually correct.
367	59912	6	13	16	13	16	Should 'defining' be 'declining'? (AUSTRALIA)	We have reworded the sentence. (This comment seems to be meant for page 13, line 19)
368	58751	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. (Connie Lovejoy, Université Laval)	We have now emphasized the density stratification as the key issue in various sections.
369	65031	6	13	20	0	0	sentence on species replacement seems speculative and uninformative. (George Hunt, University of Washington)	This sentence is now removed from the text during revision and thus the comment is no longer relevant.
370	65613	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. (Sukgeun Jung, Jeju National University)	This has been resolved with our colleagues in Ch. 30.
371	58505	6	13	34	13	36	perhaps there lose the point of "D" (lin mou, State Oceanic Administration of China, National Marine Data and Information Service)	In the revised figure any structuring using capital letters is no longer useful as the processes mentioned influence the principle mechanisms depicted in the figure but are not explicitly shown, for the sake of clarity. For an emphasis of potential climate change impacts we have improved the integration of Figure (caption) and Table 6-1.
372	58433	6	13	37	13	37	and F faunistic (Martin Pecheux, Institut des Foraminifères Symbiotiques)	In the revised figure any structuring using capital letters is no longer useful as the processes mentioned influence the principle mechanisms depicted in the figure but are not explicitly shown, for the sake of clarity. For an emphasis of potential climate change impacts we have improved the integration of Figure (caption) and Table 6-1.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
373	58243	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 Fucoids 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. (Ricardo Anadon, University of Oviedo)	This is an over-statement on what we say in our chapter. We do not exclude effects of change but described the principal vulnerability. This has now been rephrased for improved clarity. Please note that this ocean chapter cannot include extensive literature on intertidal changes.
374	79458	6	14	4	14	3	It should read "temperature and salinity" ...to be correct (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)	Salinity has been included.
375	72417	6	14	5	0	0	"Fluctuating sea level" is sufficient [delete sea level rise]. (UNITED STATES OF AMERICA)	Revised accordingly.
376	80389	6	14	5	14	5	The reference should be WGI Ch3 and Ch13. (Gian-Kasper Plattner, IPCC WGI TSU)	All references to WGI have been carefully re-checked.
377	72418	6	14	18	14	18	Introduction of jargon such as "ecosystem engineer" should be avoided. (UNITED STATES OF AMERICA)	We prefer to retain this term, but we have defined it in the text. For example " If climate change harms the species engineering benthic habitats, the entire ecosystem may be impacted.."
378	65782	6	14	26	14	26	Delete "organism" is taxa correct? (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Heading has been rephrased.
379	57585	6	14	28	0	0	next to last word in line should be "reports" (George Somero , Stanford University)	This section has been rephrased and detail lost.
380	65783	6	14	28	14	28	Delete "organism" (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	This section has been rephrased and detail lost.
381	65784	6	14	30	14	30	reverse order molecular to ecosystem? (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Yes, thank you. This is a good alternative, text now reordered from molecular to ecosystem, elsewhere in chapter.
382	65032	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. (George Hunt, University of Washington)	This is a special case that does not quite fit this generic text and would find its place in the polar chapter.
383	65785	6	14	38	14	38	rearrange order molecular to organismal effects (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	This is not possible as there is a suggested hierarchy from organismal to molecular effects and not the other way round (e.g. thermal windows are narrowest at highest level of complexity.
384	65786	6	14	42	14	42	insert brackets "(i.e. bacteria and microalgae) (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Text has been restructured, this issue is now dealt with earlier in the text. We have inserted brackets and also included more groups)
385	65787	6	14	43	14	43	delete "e.g." replace with "such as" (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Sentence has been rephrased.
386	57586	6	14	47	0	0	principal, not principle (4th word in line) (George Somero , Stanford University)	This section has been rephrased and detail lost.
387	59913	6	14	51	14	53	Perhaps it should be noted that not all marine macroorganisms have larval stages in their life histories. (AUSTRALIA)	We now only talk about eary life stages in this paragraph.
388	65788	6	15	1	15	1	replace "earth" with "Earth" (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We replaced "earth" with "Earth" here and elsewhere.
389	59914	6	15	2	15	3	This sentence is unclear. Suggest re-phrasing. (AUSTRALIA)	This section has been rephrased.
390	72419	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)	Reviewers should clearly distinguish between what the data may show and how they have been interpreted by ecologists. Food availability may involve physiological effects on feed organisms. For many examples a final answer cannot be given. The whole chapter has now been rearranged for easier flow of the reading, mechanism to ecosystem.
391	59915	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)	Yes. but this is an extrapolated statement, evidence needs to be provide. Thermal reaction norms have been observed in virtually all organism domains. This can be extrapolated to a general statement which we have now indicated.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
392	57587	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"). (George Somero , Stanford University)	This is agreed and we have simplified the legend accordingly. We found the language to be simple enough but the content too dense. The figure has been divided in two.
393	79459	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)	This detail was lost during the rewording of the figure legend.
394	77113	6	15	40	16	17	Principles of temperature effects; specifies effects on animals breathing water (I40 et seq) but needs to address air-breathing animals; not mentioned until 6.2.5.5 "Sensitivities" (Antony Diamond, University of New Brunswick)	We discuss air-breathing marine animals where relevant. Most marine animals "breathe in water" and therefore directly depend on water temperature, CO2 and O2 concentrations.
395	59916	6	16	8	16	9	This sentence is difficult to understand, suggest rephrasing. (AUSTRALIA)	The sentence has been split and reformulated.
396	65789	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. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Reference has been included.
397	77115	6	16	14	16	17	"Mechanism-based insights" etc: add example of Cairns et al. 2008 (see comment on p. 27 14 below), scaling up from physiological responses of ectotherms & endotherms to biogeographic distribution patterns related to SST (Antony Diamond, University of New Brunswick)	This is a very important suggestion and we happily include this reference in the chapter.
398	57588	6	16	25	0	0	Is the 122C-tolerant microbe a member of the Thermotogales or does it belong to the domain Archaea? (George Somero , Stanford University)	This species belongs to the Archaea. Information has now been included.
399	80682	6	16	33	0	0	May be delete "in ocean acidification" (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	Yes, this is a good idea, we deleted "in ocean acidification"
400	72420	6	16	33	17	10	The same comment (from comment 49206) applies for the acidification section 6.2.2.2. (UNITED STATES OF AMERICA)	Could not find comment 49206 in ch6 comments.
401	56549	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. (Archis Ambulkar, Brinjac Engineering Inc.)	Thank you, we removed "(OA)".
402	80683	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. (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	We agree and have removed the earlier metaanalyses. Moreover, we have included Liu in the microbial section.
403	56275	6	16	44	0	0	not clear what word "compartments" refers to (Elizabeth Mcleod, The Nature Conservancy)	It now reads "body and cell compartments".
404	59917	6	16	44	16	44	It is not clear what 'compartments' refers to - does it refer to body compartments? Please clarify (AUSTRALIA)	It now reads "body and cell compartments".
405	82044	6	16	44	16	44	To further support this statement, it would be preferable to also provide citations beyond the FAQ reference. (Katharine Mach, IPCC WGII TSU)	The consecutive references are valid. We have moved the FAQ reference accordingly.
406	57217	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 CaCO3, and which is used etc." (Erica Head, Fisheries and Oceans Canada)	Thank you, insertion "which is" adopted (two times).
407	56550	6	17	5	0	0	Space needed after word "levels" (Archis Ambulkar, Brinjac Engineering Inc.)	Space inserted.
408	80684	6	17	5	0	0	The dissolution of mollusks was clearly shown near CO2 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. (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	This reference seems more appropriate for the treatment of multiple stressors and has been included there.
409	65614	6	17	6	17	24	Table 6-5. A representative value of atmospheric pCO2 at present need to be cited here for comparison with the projected levels (for example, ~400 micro-atm in 2013) (Sukgeun Jung, Jeju National University)	Thank you, good suggestion. Included in Table legend, tables have changed, now table 6-3
410	79460	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)	We have now included this important reference, however the statement remains valid that capacity remains unexplored.
411	57218	6	17	16	17	16	Should be "Not all life stages, nor all parameters, nor the entire range etc." (Erica Head, Fisheries and Oceans Canada)	Sentence rephrased.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
412	72421	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)	Indirect effects of warming on species interactions and altered biogeography and foodwebs are now dealt with in detail in new sections 6.3.1-8.
413	72422	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)	We ensured consistency in the use of the term hypoxia throughout the chapter.
414	72423	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)	We disagree as the specific characteristics of air breathers in changing oceans needs to be highlighted.
415	57589	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. (George Somero, Stanford University)	The phenomenon may be important enough to mention it but evidence for its biological impacts is still lacking.
416	72424	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)	The phenomenon may be important enough to mention it but evidence for its biological impacts is still lacking.
417	59918	6	17	48	17	48	Should this sentence refer to all marine reptiles, rather than just turtles? (AUSTRALIA)	Agreed, sentence now mentions all reptiles.
418	59919	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)	In this chapter we can only include comparisons of air and water breathers in the same, aquatic habitat. Habitat characteristics are different in terrestrial environments.
419	72430	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)	The figure sequence has been changed.
420	57219	6	18	1	18	2	availability of prey or other, including" - this makes no sense - other what? (Erica Head, Fisheries and Oceans Canada)	We now refer to food only.
421	58752	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. (Connie Lovejoy, Université Laval)	We now mention the bowhead whales but refrain from adding references for all of them.
422	58884	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 storms reduce nutrient supply. (Svein Sundby, Institute of Marine Research)	This figure is now 6.2 and is generic for the global ocean, and not regionally specific, as it already carries much detail. Dust storms also act as a vector for pathogens, other toxic metals such as copper, and also introduce aerosols N and P into the ocean. All of these will influence ocean productivity. Why would increased storms reduce nutrient supply when they can deepen the depth of the mixed layer, and also cause the wet deposition of aerosols containing Fe, N and P.
423	57220	6	18	15	18	15	Take out the "both", since at least three factors are listed (Erica Head, Fisheries and Oceans Canada)	"both" removed.
424	59920	6	18	21	18	21	Reference to the 'productivity' of heterotrophic organisms is confusing - Is there a better way to describe this? (AUSTRALIA)	Heterotrophs also display "productivity", term should remain unchanged.
425	59921	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)	We reworded some sections for clarity, restructured the chapter and highlighted key points in the conclusions
426	72425	6	18	30	18	30	Confidence level not needed for this statement. (UNITED STATES OF AMERICA)	Paragraph rephased, we prefer to keep the confidence levels in place to reflect the certainty of knowledge.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
427	72426	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 regard 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)	The text on upscaling has been lost due to subsequent editing iterations.
428	72427	6	18	33	18	33	No confidence statement is needed for this sentence. (UNITED STATES OF AMERICA)	Paragraph rephased.
429	72428	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)	Actually quite a bit more is known about viruses than about other microbes, however, such knowledge is very limited in the context of climate change. We cite relevant literature and mention the importance of this group.
430	57221	6	18	43	18	45	The sentence that begins "Microorganisms also catalyze " appears twice. (Erica Head, Fisheries and Oceans Canada)	Deleted
431	58434	6	18	43	18	45	Repetition (Martin Pecheux, Institut des Foraminifères Symbiotiques)	Deleted
432	82045	6	18	43	18	45	The accidental repetition of the sentence here should be remedied. (Katharine Mach, IPCC WGII TSU)	Deleted
433	57590	6	18	44	0	0	A sentence is duplicated here. (George Somero , Stanford University)	Deleted
434	72429	6	18	44	18	44	Repeated sentence. Remove duplicate text. (UNITED STATES OF AMERICA)	Deleted
435	72431	6	19	1	19	1	This paragraph appears to use microbe and phytoplankter interchangeably. Use consistent terminology. (UNITED STATES OF AMERICA)	issue resolved.
436	57222	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. Tadolé, R.D. (2012) Temperature, resources, and phytoplankton size structure in the ocean. Limnol. Oceanogr. 57(5), 1266-1278 (Erica Head, Fisheries and Oceans Canada)	We have included both references.
437	82046	6	19	6	19	7	It would be helpful to specify the general time frame for this statement. (Katharine Mach, IPCC WGII TSU)	Amended
438	65790	6	19	7	19	7	Delete "However" start sentence with "Further" (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Amended
439	65791	6	19	8	19	8	Insert "however" to give "...are , however, required..." (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Amended
440	65792	6	19	12	19	12	replace "phytoplankter" with phytoplankton (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Amended
441	72432	6	19	19	19	19	Confidence level not critical for this statement. (UNITED STATES OF AMERICA)	Amended
442	58753	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. (Connie Lovejoy, Université Laval)	Thank you for suggesting this reference, but we did not see a way to include this reference which has a very regional focus.
443	58754	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 satellites detect (Connie Lovejoy, Université Laval)	We now cite the Hill et al. 2013 study and mention the issue of deeper water NPP not detected by satellites.
444	56551	6	19	31	0	0	Should the value be "8.1" instead of "8,1" (Archis Ambulkar, Brinjac Engineering Inc.)	Amended
445	59922	6	19	32	19	33	Sentence beginning 'in addition' could be clearer. Suggest re-phrasing. (AUSTRALIA)	Amended
446	57223	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)." (Erica Head, Fisheries and Oceans Canada)	The offending sentence has been altered to reflect these concerns as follows - "As some krill feed primarily on sea-ice algae, it is unclear (low confidence) whether they will adapt to feeding mainly on free-drifting phytoplankton (Smetacek and Nichol, 2005)." The suggested sentence was too long to be included in full.
447	65033	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 (George Hunt, University of Washington)	There is insufficient scope or space in this chapter to add these - they would be more relevant to the polar WG2 chapter.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
448	61936	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. (Dag Lorents Aksnes, University of Bergen)	These trends in the text are based on the converging views from numerous modelling experiments that conclude that a future ocean will have denser stratification and shallower mixed layers.
449	59923	6	19	41	19	51	The progression of the argument in this paragraph is unclear. Suggest re-phrasing. (AUSTRALIA)	This paragraph has been reordered and rewritten to clarify this argument.
450	57224	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? (Erica Head, Fisheries and Oceans Canada)	This text has rewritten and clarified..
451	57225	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." (Erica Head, Fisheries and Oceans Canada)	Boyce et al. Use a blended dataset approach - from sechi discs to satellite remote sensing to look at trends over the last 100 years - this is reflected in our discussion within Ch. 6
452	57227	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)." (Erica Head, Fisheries and Oceans Canada)	This text has been modified and the Richardson and Shoeman reference is now cited.
453	57231	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)." (Erica Head, Fisheries and Oceans Canada)	We have addressed this issue by citing examples from these other studies - such as by Ohman et al. (2010).
454	58885	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. (Svein Sundby, Institute of Marine Research)	We have addressed this issue by citing examples from these other studies - such as by Ohman et al. (2010).

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
455	57226	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. (Erica Head, Fisheries and Oceans Canada)	We now discuss the issue of length of the time-series of phytoplankton observations and what they can tell us about climate variability and change.
456	57229	6	20	3	20	3	Change "across" to "throughout" (Erica Head, Fisheries and Oceans Canada)	amended
457	79461	6	20	4	20	4	Should it say "resident" rather than "residence"? (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)	changed
458	57230	6	20	6	20	7	Boyce et al. (2010) did not make any strong predictions (projections) into the future and niether 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: (Erica Head, Fisheries and Oceans Canada)	The reviewer is correct, and the revised text now makes no reference to any future projections by any of these authors, but only refers to this 'blended' 100 year time-series.
459	58886	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 that 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? (Svein Sundby, Institute of Marine Research)	Agreed, text changed to "revealed a large variety of trends at scales of several decades but a general increase in NPP on most shelves (Sherman and Hempel, 2009; Bode et al., 2011), possibly caused by climate variability, climate change, and anthropogenic eutrophication. Recent field studies point to a growing fraction of NPP fertilized by atmospheric N in large ocean basins..."
460	65034	6	20	15	0	0	should something that is only putative be in this document. Is this result not believed? (George Hunt, University of Washington)	The descriptor 'putative' has been removed from the final Chapter version.
461	56552	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. (Archis Ambulkar, Brinjac Engineering Inc.)	amended
462	58435	6	20	26	20	26	...carbon-concentrating mechanism of bicarbonate, CCM's (Martin Pecheux, Institut des Foraminifères Symbiotiques)	We prefer to leave as "carbon-concentrating mechanisms" as this is convention.
463	80686	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" (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	While we agree on the results of the metaanalysis, we cannot dismiss the variability in the results. Especially for coccolithophores we have to emphasize the variability in the respective findings which is not as clearly done when forming an overall mean and a standard deviation. the metaanalysis does not take into account the variability of responses.
464	80687	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. (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	We agree on the set of reasons that could lead to conflicting results and have developed a more in depth rationale for the specific aspects in our chapter that goes beyond the meeting discussions of this issue.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
465	79462	6	20	36	20	36	Should it say "to estimate" rather than to be estimated"? (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)	amended
466	58436	6	20	41	20	41	Add: Emiliana huxleyi is a particular species as it blooms in subpolar water, contrary to all other photosynthetic marine calcifiers (Martin Pecheux, Institut des Foraminifères Symbiotiques)	We prefer not to add this - as there is increasing evidence from sub-polar waters that other coccolithophore species are also important in bloom formation.
467	59924	6	20	41	20	41	It would be useful to remind the audience how climate change might influence nitrogen limitation and light levels. (AUSTRALIA)	This is illustrated in Figure 6.9 (now 6.2) and discussed in the text.
468	58437	6	20	44	20	44	Add: Almost nothing is known on effect of OA on competition fitness at ecosystem level. (Martin Pecheux, Institut des Foraminifères Symbiotiques)	This is beyond the scope of the coverage of this section in our chapter.
469	65035	6	21	5	0	0	define CCMs- and get rid of acronyms! (George Hunt, University of Washington)	we prefer to leave as "carbon-concentrating mechanisms" but also to include the CCM as a standard parameter.
470	80688	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 pCO2 (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 CO2 in the South Pacific. Global Change Biology 18:3004-3014.) (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	We have retained this reference but have added a qualifier stating the location of these coastal blooms. We have included the Law et al. reference (p 26. line 17.)
471	61935	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. (Dag Lorents Aksnes, University of Bergen)	This section focuses on temperature and ocean acidification. We now included two studies considering the role of changes in light availability and their consequences for macrophytes under 6.3.5.
472	65036	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 (George Hunt, University of Washington)	This is a good point now adopted for the sake of being comprehensive, reference included. Details would have to be considered in the polar chapter.
473	80689	6	21	41	0	0	Macrophytes are not in the "transition zone to coastal waters", they are in coastal waters. (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	This is really a matter of definition. We have removed the mention of transition zone.
474	80691	6	21	43	0	0	Reference to Fig. 6-7 should be removed as this figure does not address macrophytes (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	Reference to fig 6-7 seems appropriate because this reference is for thermal response curves in general.
475	80690	6	21	47	0	0	Acclimation, rather than acclimatization? (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	Acclimatization is the correct term as it refers to the acclimatization potential in the field, not in the lab.
476	80692	6	22	1	0	0	Add a link to 5.4.2.3, where this issue is covered with more detail. (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	We added a link to 5.4.2.3 Wetland and Seagrasses Beds.
477	80695	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. (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	For some groups Kroeker et al found OA-reduced calcification, and an OA-increased photosynthesis (fig4). The non-significant results resulted when all investigated species were pooled together. In this report we cannot average out relevant between species differences.
478	80693	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. (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	Reference included.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
479	58438	6	22	7	22	7	...increased under normal temperature with rising CO2 (Martin Pecheux, Institut des Foraminifères Symbiotiques)	Section revised, wording has changed differently.
480	72433	6	22	12	22	12	The statement "...macrophytes specialize on limited temperature ranges..." is confusing. Please clarify meaning. (UNITED STATES OF AMERICA)	It now reads "...macrophytes have limited temperature ranges..."
481	59925	6	22	12	22	14	The expectation that macrophytes (seaweeds and seagrasses) will be more competitive than calcifying organisms in a high CO2 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)	We adopted suggested wording for the sentence, now reads "macrophytes (seaweeds and seagrasses) will be more competitive than calcifying organisms in a high CO2 ocean". The respective information is also included in the Executive summary.
482	80694	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. (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	Expert judgement is a valid approach. As we reworded this sentence, the question of benefit or not is not relevant any more.
483	58244	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 temperature 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] (Ricardo Anadon, University of Oviedo)	This point is well taken and a matter of body size which is now included.
484	59926	6	22	19	22	22	It could be useful to have these definitions of ectotherms and endotherms earlier in the chapter. (AUSTRALIA)	Thanks for the comment. This is the first reference to those concepts in the chapter, and there is no natural niche for the definition earlier in the text.
485	56733	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 (JOSEP LLORET, UNIVERSITY OF GIRONA)	We refrained from mentioning this very regional index which would be relevant in a regional treatment.
486	72434	6	22	26	22	54	This section could benefit 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 redundancy or potential contradiction. (UNITED STATES OF AMERICA)	We acknowledge the observation. Several references on documented range shifts (ecological scale) are included later in the chapter (section 6.3.2.1). And crosschecked with chp30.
487	58887	6	22	29	22	29	Should be: AMO and NAO (Svein Sundby, Institute of Marine Research)	Detail lost during editing.
488	79463	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)	Detail lost during editing and setting up of a crosschapter box on biogeography.
489	65793	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. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We have included the reference.
490	58888	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: increasing productivity. Cooling decreasing productivity(Drinkwater 2006; Sundby and Nakken 2008) (Svein Sundby, Institute of Marine Research)	Movement is not a sign of evolutionary adaptation to temperature, in a physiological sense. Adaptation would involve changing thermal tolerances and a capacity to stay in place which these fishes are apparently not doing. They rather track their preferred temperatures. This is now made clearer.
491	59927	6	23	8	23	9	The link between the sentence beginning 'indirect effects' and the rest of the paragraph is unclear. Please clarify. (AUSTRALIA)	Paragraph has changed during editing.
492	64471	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). (Teunis Jansen, Danish Technical University - National Institute of Aquatic Resources)	The table had to be cut back to key examples, so it was not possible to include this specific aspect.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
493	79464	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)	Simpson et al 2011 is cited in the chapter where appropriate. However, due to condensing tables, we did not include it in the table (now tab6-2).
494	79465	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)	While this is a very interesting finding, the case does not naturally fit in the table since there is a mechanism, but not a clear phenomenon related to long term changes (in abundance, phenology, distribution).
495	57591	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. Hoffelt, 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. (George Somero, Stanford University)	We have included the reference.
496	59928	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)	Sentence has changed during editing.
497	65615	6	24	18	24	19	The last sentence needs to be written in relation to variability in carbon dioxide. (Sukgeun Jung, Jeju National University)	Sentence has changed during editing, CO2 is now mentioned.
498	56553	6	24	25	24	26	Sentence needs to be revised properly to adjust "comma" and "(" (Archis Ambulkar, Brinjac Engineering Inc.)	Sentence has changed during editing.
499	79466	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)	This is a metaanalysis that has been published in the meanwhile.
500	79467	6	25	3	25	3	What about 'bottom up' food-web impacts on fish? (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)	This section deals mostly with physiological sensitivity, trophic interactions are addressed in 6.3.6.
501	80700	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., Lézé B., Feely R. A. & Murphy E. J., 2012. Extensive dissolution of live pteropods in the Southern Ocean. Nature Geoscience 5:881–885. (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	We have included the reference.
502	79468	6	25	8	25	8	It should read "Some species exhibited enhanced"....to be correct (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)	Sentence has changed during editing.
503	65616	6	25	14	25	16	Requiring citations of published papers supporting the 2 sentences (Sukgeun Jung, Jeju National University)	This text is a high level distillation from the literature. References are those supporting present Table 6-3.
504	80701	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-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. (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	The main message in the paragraph is the enhancement of sensitivity to one forcing during suboptimal levels of the other, and does not attempt to be exclusive. We have now included calcification as a relevant process and mentioned two references by the Gattuso group.
505	72435	6	25	43	25	43	Please define climate zone in this section. (UNITED STATES OF AMERICA)	Sentence has changed during editing.
506	80702	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. (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	While there are several definitions of reef e.g. a reef is a structure made by organisms growing on top of each other and can be made by a wide range of organisms. As this seems like a contentious issue we agree to use the term communities once warm- and cold water corals are compared.
507	80703	6	26	4	0	0	Reef-building rather than tropical (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	Sentence has changed during editing
508	80704	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. (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	The section has been condensed and made more relevant for the assessment.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
509	58439	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-guldberg 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). (Martin Pecheux, Institut des Foraminifères Symbiotiques)	In response to comment 508 the section has been focussed on the assessment and this information has been cut.
510	56276	6	26	10	0	0	"disturbed excitation processing within the light harvesting centers of photosynthesis" -- could this be stated more simply - no idea what it means (Elizabeth Mcleod, The Nature Conservancy)	This text has since been deleted.
511	56277	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?" (Elizabeth Mcleod, The Nature Conservancy)	Sentence has changed during editing.
512	82047	6	26	13	26	15	It would be helpful to specify the general time frame for the observed change in coral abundance. (Katharine Mach, IPCC WGII TSU)	This detail is covered in Box-CR.
513	56278	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. (Elizabeth Mcleod, The Nature Conservancy)	Sentence has changed during editing.
514	58440	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.) (Martin Pecheux, Institut des Foraminifères Symbiotiques)	The content of this statement is well implicated in the present text which we had to shorten and cut back on references rather than add more.
515	72436	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)	This report states that "as a result of demographic and monitoring limitations, species-level abundance and trend data were virtually non-existent for most of the 82 candidate coral species under consideration". The report is an important starting point but its values for our assessment is limited. For reasons of space constraints we therefore focus on the larger scale processes also acknowledged in the report. We cite this review under multiple stressors now. 6.3.5.
516	80705	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. (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	we are afraid we cannot provide a full literature review, but in cases are referring to previous reviews or have to be selective and chose examples. In this case we have cut back even further.
517	80706	6	26	21	26	27	Manzello et al. Did not investigate a CO2 seep but regular reefs in the eastern Pacific (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	Citation of this reference has been adjusted.
518	56279	6	26	26	0	0	sentence beginning "heterotrophic feeding supporting resilience" should be clarified (i.e., how does heterotrophic feeding support resilience) (Elizabeth Mcleod, The Nature Conservancy)	Sentence has changed during editing.
519	59929	6	26	26	26	27	This sentence is difficult to understand. Suggest re-phrasing. (AUSTRALIA)	Sentence has changed during editing.
520	58441	6	26	29	26	29	Summer temperature acting... (Martin Pecheux, Institut des Foraminifères Symbiotiques)	Sentence has changed during editing.
521	59930	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)	This important distinction is now mentioned in the Introduction and discussed in 6.3.2.2
522	80707	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. (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	The comment is not very clearly formulated which makes it difficult to assess. We read it to state that not all temperature Co2 interaction is due to bleaching as reported in the cited paper and have changed the text accordingly and included the reference.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
523	80708	6	26	29	26	33	This paragraph partly duplicates information presented earlier. (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	The paragraph refers to the combined effects of high temperature (first paragraph) and OA (second paragraph), and its therefore complementary, not redundant.
524	58442	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. (Martin Pecheux, Institut des Foraminifères Symbiotiques)	we are afraid we cannot provide a full literature review, but in cases are referring to previous reviews or have to be selective and chose examples. In this case we have cut back even further.
525	59931	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)	The cited scenarios are those applied by the mesocosm experiment, comparable RCP scenarios are now provided.
526	80709	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.) (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	We have rearranged the writing and discuss gene expression studies including this one together with others under 6.3.2. as all of them have been done merely under CO2.
527	66245	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 (Cornelia Maier, Laboratoire d'Océanographie de Villefranche sur Mer)	Very interesting paper, and comment. we have included the paper in the chapter but under CO2 effects.
528	80710	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 (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	We are grateful for this update and have included selected references for an updated picture on the sensitivity of cold water corals to ocean acidification.
529	56280	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. (Elizabeth Mcleod, The Nature Conservancy)	Sentence has changed during editing
530	61105	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. (European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)	Sentence has changed during editing. The assessment has benefited from further studies that recently became available.
531	65037	6	26	37	0	0	how about evidence rather than proof? (George Hunt, University of Washington)	Phrasing has been changed completely with editing.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
532	66246	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 (Cornelia Maier, Laboratoire d'Océanographie de Villefranche sur Mer)	We are grateful for this update and have included selected references for an updated picture on the sensitivity of cold water corals to ocean acidification.
533	56554	6	26	38	0	0	The "()" should be removed for Maier et. Al. 2009, considering the structure of sentence. (Archis Ambulkar, Brinjac Engineering Inc.)	Agreed and amended.
534	82048	6	26	41	26	41	Casual usage of "likely" should be avoided. (Katharine Mach, IPCC WGII TSU)	Agreed and amended.
535	56281	6	27	1	0	0	extreme weather in addition to sea-level rise can lead to both flooding and erosion of turtle nesting beaches (Elizabeth Mcleod, The Nature Conservancy)	Agreed and amended in 6.3.7.
536	79469	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)	Interesting topic. Unfortunately we have reduced the amniote-related information to reduce the chapter and balance with other topics. Thanks for the suggestion.
537	77116	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 (Antony Diamond, University of New Brunswick)	Very interesting paper, and comment. we have included the paper in the chapter.
538	56555	6	27	21	0	0	SST term is not defined or elaborated in this chapter prior to being used in this sentence (Archis Ambulkar, Brinjac Engineering Inc.)	Agreed, attended.
539	59932	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)	Sentence has been rephrased for improved clarity.
540	58755	6	27	46	27	48	But less ice would likely be bad for Bowheads and Belugas (see Ferguson et al 2010 cited above) (Connie Lovejoy, Université Laval)	Section eliminated.
541	56282	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? (Elizabeth Mcleod, The Nature Conservancy)	Sentence has changed during editing
542	72437	6	27	52	27	54	As written, the sentence is awkward and unfocused (UNITED STATES OF AMERICA)	Sentence has changed during editing
543	72438	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)	Sentence has changed during editing
544	82049	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. (Katharine Mach, IPCC WGII TSU)	The title and the structure of 6.3 have been comprehensively revised.
545	72439	6	28	25	28	25	Should this read "affects are accelerated..." ? (UNITED STATES OF AMERICA)	No - it should read "effects" as written.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
546	58245	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 Ghinagliae, 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. (Ricardo Anadon, University of Oviedo)	We did not include this reference because this is a regionally specific NPP reference and so it belongs in Ch 30.
547	58756	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. Matraj, 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. (Connie Lovejoy, Université Laval)	We do not make such a claim, but instead report pan-Arctic trends in NPP over a decade of remote sensing. We included the reference.
548	72440	6	28	45	28	45	Are these higher NPP rates attributed to climate change? (UNITED STATES OF AMERICA)	This text has now been clarified.
549	72441	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)	This section has now been rewritten to address this issue.
550	82050	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. (Katharine Mach, IPCC WGII TSU)	This section is now rewritten to address this issue.
551	58889	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 (Svein Sundby, Institute of Marine Research)	We now have a cross-chapter box on biogeography. So we have resolved the overlap issue.
552	82051	6	29	10	29	10	The chapter team could consider placing "high confidence" within parentheses at the end of the sentence. (Katharine Mach, IPCC WGII TSU)	This section is now revised.
553	64472	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, Turrell 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. (Teunis Jansen, Danish Technical University - National Institute of Aquatic Resources)	This table has now been revised and transformed into one with illustrative examples on the mechanisms linking biogeography, phenology and abundance shifts.
554	57232	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 (Erica Head, Fisheries and Oceans Canada)	This table is now revised and transformed into an illustrative example table on the mechanisms linking biogeography, phenology and abundance shifts.
555	57233	6	29	22	29	24	"Between the 1970s and the 1990s there were increases in abundances of the arctic copepod species Calanus hyperboreus and Calanus glacialis and the dinoflagellate Ceratium arcticum on the Newfoundland Shelf, due to increased contribution of Arctic water, via the shelf branch of the Labrador Current." (Erica Head, Fisheries and Oceans Canada)	This table is now revised and transformed into an illustrative example table on the mechanisms linking biogeography, phenology and abundance shifts.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
556	57234	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! (Erica Head, Fisheries and Oceans Canada)	This table is now revised and transformed into an illustrative example table on the mechanisms linking biogeography, phenology and abundance shifts.
557	79470	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)	This table is now revised and transformed into an illustrative example table on the mechanisms linking biogeography, phenology and abundance shifts.
558	64237	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)	The reference is now included into our North Atlantic Box 6-1.
559	65038	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 (George Hunt, University of Washington)	The section is now merged into a cross chapter box on biogeography.
560	65617	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. (Sukgeun Jung, Jeju National University)	The section is now merged into a cross chapter box on biogeography.
561	61106	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. (European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)	The reference is now included as an example into our treatment of multiple stressors, 6.3.5.4.
562	79471	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)	This figure is now revised to increase clarity
563	57235	6	29	51	29	51	The "orange line" is almost too faint to see on the version of Fig. 6-11 that I have. (Erica Head, Fisheries and Oceans Canada)	This figure is now revised to increase clarity.
564	58246	6	30	16	0	0	I suggest to incorporate the changes in other macroalgal groups dominant in some North East Atlantic waters like Fucaeans that shows a very rapid decline in their southern limit [Lamela, C., Fernández, C., Arrontes, J. y Anadón, R. 2012. Fucooids Assemblages on the North Coast of Spain: Past and Present (1977-2007). Bot.Mar., 55: 199-207 (Ricardo Anadon, University of Oviedo)	This section is now extensively revised, with much of the materials on biogeography now summarized in a new cross-chapter box. The number of individual examples that can be cited is limited. We apologize. In depth regional or coastal treatment is up to chapter 30 or 5, respectively.
565	65794	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. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Reference added.
566	58443	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. (Martin Pecheux, Institut des Foraminifères Symbiotiques)	The text has been revised to clarify this.
567	82052	6	30	19	30	19	If being used as a likelihood term, "likely" should be italicized. Casual usage should be avoided. (Katharine Mach, IPCC WGII TSU)	The text has now been revised.
568	65795	6	30	24	30	24	Delete "British" replace with "English" (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	This section is now extensively revised.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
569	65796	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. <i>Journal of Biogeography</i> , 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? <i>Global Change Biology</i> , 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. <i>Global Change Biology</i> , 13: 2065-2077. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	This section is now extensively revised, with much of the materials on biogeography now summarized in a new cross-chapter box with chapter 30. Lima et al 2007 is now cited in our chapter and the new CC-Box.
570	72442	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)	This section is now revised, with much of the materials on phenology now summarized in a new cross-chapter box. A global metaanalysis by Poloczanska et al. (2013) is cited.
571	82053	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. (Katharine Mach, IPCC WGII TSU)	Agreement statement is now included in the cross-chapter box on biogeography and phenology.
572	56734	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. <i>Fisheries Research</i> 48:79-96; Ratz and Lloret 2003. <i>Fisheries Research</i> 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. <i>Reviews in Fisheries Science</i> , 20:3, 165-180 (JOSEP LLORET, UNIVERSITY OF GIRONA)	We have mentioned the temperature effects on fish growth. Also, we have included materials on temperature effects on disease and parasites. We have included the reference
573	82054	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. (Katharine Mach, IPCC WGII TSU)	Sentence and section has been restructured, detail lost.
574	65797	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. <i>Global Change Biology</i> 16: 517-527. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Reference added.
575	66253	6	31	0	31	0	Box-1. Should be removed or integrated within Chapter 30. (Geir Ottersen, Institute of Marine Research)	Box 1 is now revised to focus on describing generalized mechanisms using the North Atlantic as a case study .
576	82055	6	31	3	31	3	The chapter team could consider placing "high confidence" within parentheses at the end of the sentence. (Katharine Mach, IPCC WGII TSU)	Done consistently throughout chapter now.
577	58759	6	31	3	31	15	There is a lack of appreciation of how microrbial 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. (Connie Lovejoy, Université Laval)	Section 6.3 is now revised and we have a subsection specifically to cover temperature effects on mircobes and phytoplankton. We have included the reference.
578	82056	6	31	11	31	11	The chapter team could consider placing "high confidence" within parentheses at the end of the sentence. (Katharine Mach, IPCC WGII TSU)	Done consistently throughout chapter now.
579	65798	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. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We have added the reference.
580	82057	6	31	20	31	20	The chapter team could consider placing "very high confidence" within parentheses at the end of the sentence. (Katharine Mach, IPCC WGII TSU)	Done consistently throughout chapter now.
581	72443	6	31	22	31	22	Listing of "high confidence" not necessary. (UNITED STATES OF AMERICA)	This section has now been rewritten, assignment of confidence statements has been revised.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
582	61107	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. (European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)	The vulnerability of coral reefs to climate change is highlighted in the executive summary.
583	58444	6	31	25	31	25	...reefs are the Earth ecosystem most affected by climate change (Martin Pecheux, Institut des Foraminifères Symbiotiques)	The statement that coral reefs are among the marine ecosystems most affected by climate change and warming reflects accurately on our assessment.
584	58890	6	31	31	32	51	Box 6.1 Much redundancy with Chapter 30 (Svein Sundby, Institute of Marine Research)	The chapter has been revised to reduce redundancy between chapters.
585	79472	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)	Section 6.3 and box 6-1 have been edited to improve readability.
586	56556	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. (Archis Ambulkar, Brinjac Engineering Inc.)	Since this is a Box, it should be able to be understood by readers without the main text and thus we redefine the acronyms used.
587	58757	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. (Connie Lovejoy, Université Laval)	The regional focus of this study is now mentioned in the revised text. The criticized section is about interaction with diatoms, not the principle effect of high temperature on dinoflagellates.
588	57236	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)." (Erica Head, Fisheries and Oceans Canada)	This is now revised.
589	59933	6	31	49	31	54	The importance of the distinction between diatoms and dinoflagellates could be better explained. (AUSTRALIA)	Revised to clarify this point.
590	57237	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. Tardonléké, R.D. (2012) Temperature, resources, and phytoplankton size structure in the ocean. Limnol. Oceanogr. 57(5), 1266-1278 (Erica Head, Fisheries and Oceans Canada)	The section has been revised as suggested.
591	72444	6	32	4	32	4	Listing of "low confidence" not necessary. (UNITED STATES OF AMERICA)	This is now revised. Confidence statement is on the linkages between SST and jellyfish outbreak.
592	57238	6	32	10	32	10	Replace "Surpassing" with "Above the CTB there were pronounced etc" (Erica Head, Fisheries and Oceans Canada)	This is now revised accordingly.
593	79473	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)	This is now revised accordingly.
594	65799	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. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We do not aim to provide an exhaustive list of literature on the topic here. Instead, the box has been revised to provide selected examples which illustrate the mechanisms behind the observed changes.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
595	64470	6	32	33	0	0	(Box 6-1). I suggest adding "and Atlantic mackrel (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 (<i>Scomber scombrus</i>) in Autumn and Winter. PLoS One, 7 (12). (Teunis Jansen, Danish Technical University - National Institute of Aquatic Resources)	We do not aim to provide an exhaustive list of literature on the topic here. Instead, the box has been revised to provide selected examples which illustrate the mechanisms behind the observed changes.
596	57239	6	32	33	32	33	Replace "being effective" with "having the greatest effect" (Erica Head, Fisheries and Oceans Canada)	This is now revised accordingly.
597	79474	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)	The box is revised to provide selected examples to illustrate the mechanisms behind the observed changes.
598	57240	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)." (Erica Head, Fisheries and Oceans Canada)	This is now revised accordingly.
599	82058	6	32	45	32	45	Casual usage of "likely" should be avoided. (Katharine Mach, IPCC WGII TSU)	This is now revised and "likely" is not used casually.
600	72445	6	33	2	33	2	Clearly define OMZs. (UNITED STATES OF AMERICA)	defined under 6.1.1
601	72446	6	33	4	33	6	Will this transition occur everywhere or only in certain regions? (UNITED STATES OF AMERICA)	Only in certain regions where OMZs exist. Wording should be clearer now-
602	72447	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)	The writing should make clear that phenomena currently observed in OMZs will expand with their expansion.
603	82059	6	34	5	34	5	The chapter team could consider placing "medium confidence" within parentheses at the end of the sentence. (Katharine Mach, IPCC WGII TSU)	Done consistently throughout chapter now.
604	82060	6	34	7	34	7	The chapter team could consider placing "high confidence" within parentheses at the end of the sentence. (Katharine Mach, IPCC WGII TSU)	Done consistently throughout chapter now.
605	72448	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)	The sentence means to say that higher organisms are affected in their distribution depending on the degree of hypoxia reached.
606	82061	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. (Katharine Mach, IPCC WGII TSU)	This has been phrased as a conditional scenario in reference to the uncertainty on future hypoxic volumes outline in 6.1.1
607	56557	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. (Archis Ambulkar, Brinjac Engineering Inc.)	Now defined on page 4 and written in full in each major section, as a reminder. Otherwise the acronym OA is used.
608	58445	6	34	15	34	15	(hour) not (h) (Martin Pecheux, Institut des Foraminifères Symbiotiques)	Hours now written in full.
609	80711	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. (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	These inconsistencies in language have now been addressed throughout the chapter.
610	72449	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)	There are insufficient data to address this important topic in AR5. The difference to findings in a temperature context should now be clearer
611	80712	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. Ices Journal of Marine Science 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. Nature Climate Change 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. Geophysical Research Letters 36, L18608. doi:10.1029/2009GL039901. (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	We agree on these valid points. We have included some references and discussed the underlying reasons.
612	82062	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?? (Katharine Mach, IPCC WGII TSU)	Detail lost during revision.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
613	56283	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. (Elizabeth Mcleod, The Nature Conservancy)	Detail lost and text revised for clarity.
614	80713	6	34	37	0	0	You should perhaps explain why. (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	This has been done in the respective text sections.
615	57241	6	34	46	34	46	Replace "reaction" with "response" (Erica Head, Fisheries and Oceans Canada)	Detail lost and text revised for clarity.
616	72450	6	34	53	34	53	Replace "Such a decrease", by: " A decrease of 0.1 in pH" corresponds to... (UNITED STATES OF AMERICA)	Text revised for clarity by adding "mean" rise in CO2.
617	58446	6	34	53	34	54	as already happened (Martin Pecheux, Institut des Foraminifères Symbiotiques)	We prefer not to make this change as this would tilt the meaning of earlier statements.
618	80715	6	35	6	0	0	The publication date of Joint et al. is 2011 (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	Agreed and amended.
619	80716	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. (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	Agreed and amended.
620	80718	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." (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	Agreed and amended.
621	82063	6	35	16	35	16	The chapter team could consider placing "high confidence" within parentheses at the end of this part of the sentence. (Katharine Mach, IPCC WGII TSU)	Done consistently throughout chapter now.
622	82064	6	35	21	35	21	The chapter team could consider facing "medium confidence" within parentheses at the end of the sentence. (Katharine Mach, IPCC WGII TSU)	Done consistently throughout chapter now.
623	57242	6	35	27	35	27	Replace "parts" with "part" (Erica Head, Fisheries and Oceans Canada)	Agreed and amended.
624	56558	6	36	10	0	0	Add comma as "For cold-water corals, experimental..." (Archis Ambulkar, Brinjac Engineering Inc.)	Sentence and section has been restructured, detail lost.
625	80719	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)." (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	Sentence altered to "The cold-water coral, <i>L. pertusa</i> shows resilience to ocean acidification".
626	72451	6	36	11	36	11	"The reduction of salinity associated with freshwater input results in lower alkalinity, exacerbates OA": dilution also decreases the pCO2 and increases the pH such that it depends on how acidification is defined. A more thorough discussion of the relationship between freshening, CO2 and pH is warranted. (UNITED STATES OF AMERICA)	This changes in physicochemistry of the water in response to dilution have been explained more clearly.
627	61108	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. (European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)	The suggestion has been added to the ES.
628	82066	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. (Katharine Mach, IPCC WGII TSU)	Emissions added as indeed a stop in emissions would lead to a surface water amelioration though the deep ocean will take 1500 year to revert to near normal.
629	82065	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. (Katharine Mach, IPCC WGII TSU)	The confidence statements have been placed at the end of the sentences throughout.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
630	80720	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. (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	In our discussion of individual groups we report the respective findings. As to summary statements, e.g. on open ocean NPP, while we recognise the importance of expert surveys, the necessary brevity of statements in these surveys does not allow for a critical and balanced assessment. Therefore, we are restricting our discussion to the assessment of the primary literature. We agree that OA may stimulate NPP but emphasize that there is low confidence in its predictability as discussed in the cross chapter box.
631	56284	6	36	22	0	0	the severity of the effects depends on the scenario followed but ALSO on the ecosystem/species response (Elizabeth Mcleod, The Nature Conservancy)	We start the paragraph now with re-emphasizing the species specific responses to the stressors and then discuss the emissions.
632	56735	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 (JOSEP LLORET, UNIVERSITY OF GIRONA)	This has been covered by Ch 5 on Coastal systems. (This comment seems to be meant for page 38, lines 3-6)
633	57243	6	36	44	36	45	Replace "Casini et al., 2009), however, they may" with "Casini et al., 2009), although they may" (Erica Head, Fisheries and Oceans Canada)	Sentence has been rephrased for improved clarity.
634	65800	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. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	This study is included in the section on food webs, now 6.3.6.
635	56559	6	36	47	0	0	Need to change "-", not sure if they are needed i.e. "concentrations - (xxxx) - or..." (Archis Ambulkar, Brinjac Engineering Inc.)	Dashes have been eliminated.
636	57786	6	37	4	37	4	comparable paleo-events - such as? (Ronald Stouffer, Geophysical Fluid Dynamics Laboratory/NOAA)	PETM added as an example.
637	58447	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 (Martin Pecheux, Institut des Foraminifères Symbiotiques)	We currently have no evidence that the K/Pg boundary was associated with Ocean acidification.
638	72452	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)	The duration is not relevant as the rate of change is the important factor for the adaptability of organisms. The age was changed to 55.3 Ma and mentioned the first time the PETM was referred to.
639	57244	6	37	6	37	6	Move a comma thus "Schmidt, 2010) when, similar to today, OA etc" (Erica Head, Fisheries and Oceans Canada)	Sentence was deleted.
640	57245	6	37	10	37	10	Replace "however," with "although" - noting the omission of the comma (Erica Head, Fisheries and Oceans Canada)	Sentence was deleted.
641	58448	6	37	10	37	12	. The Cretaceous/Tertiary (65 Ma) and the Permian Triassic (251 Ma)... (Martin Pecheux, Institut des Foraminifères Symbiotiques)	Sentence was deleted.
642	68890	6	37	21	37	21	Still question marks in the text. (NETHERLANDS)	We have specified the questionmarks as "unknown".
643	57246	6	38	1	38	1	Change to "cause shrinkage of biogeographical ranges (Figure 6-7)" - noting the omission of the comma. (Erica Head, Fisheries and Oceans Canada)	Sentence has been rephrased for improved clarity.
644	58449	6	38	6	38	9	Say which species are studied by the references (Martin Pecheux, Institut des Foraminifères Symbiotiques)	As several species are mentioned in the papers, we like to keep the statement general to avoid extending the text too much, the reader is referred to the original papers.
645	56560	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. (Archis Ambulkar, Brinjac Engineering Inc.)	Sentence deleted.
646	59934	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)	We have added a basic introduction to the beginning of 6.3 to address this need.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
647	58891	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 (Svein Sundby, Institute of Marine Research)	The sentence has been deleted and the content moved to a cross chapter box.
648	58247	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 anlaysia 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. (Ricardo Anadon, University of Oviedo)	Regional examples have been cut from this paragraph. However, this is at least at some degree considered in the new CC upwelling box. Thanks for the suggestion.
649	58248	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. (Ricardo Anadon, University of Oviedo)	This is at least to some degree considered in the new CC upwelling box. Thanks for the suggestion. Due to space constraints only a limited number of references could be cited.
650	65801	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. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Very interesting paper; although, the mechanism is not that direct (multifactorial), and not easily extrapolated to the rest of the upwelling systems, i.e. its not a general pattern or process.
651	57247	6	39	16	39	16	On the Figure 6-13 the box labeled "Phenology shift" should be labeled "Phenological shift" (Erica Head, Fisheries and Oceans Canada)	Figure revised accordingly.
652	79475	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)	This is now clarified.
653	80721	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..." (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	we see ocean acidification at the same level as ocean warming and this is now also considered in the Box CC-OA.
654	82067	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). (Katharine Mach, IPCC WGII TSU)	Done consistently throughout chapter now.
655	57248	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" (Erica Head, Fisheries and Oceans Canada)	Sentence has been rephrased for improved clarity.
656	65802	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. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We have already cited 3 references here to support our statement. The recommended study has been cited in the respective ecosystem section 6.3.1.
657	80722	6	40	5	0	0	Reef-building rather than tropical (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	Agreed and amended.
658	82068	6	40	11	40	12	The chapter team could consider placing "high confidence" within parentheses at the end of the statement. (Katharine Mach, IPCC WGII TSU)	Done consistently throughout chapter now.
659	82069	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." (Katharine Mach, IPCC WGII TSU)	Done consistently throughout chapter now.
660	57249	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". (Erica Head, Fisheries and Oceans Canada)	Sentence has changed during editing.
661	56561	6	40	26	0	0	Word "body" repeated twice in the sentence, please delete one. (Archis Ambulkar, Brinjac Engineering Inc.)	Sentence has changed during editing.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
662	57250	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)." (Erica Head, Fisheries and Oceans Canada)	Sentence has changed during editing.
663	58249	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. (Ricardo Anadon, University of Oviedo)	Agreed, included (listed) among main ecosystem services.
664	56285	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 (Elizabeth Mcleod, The Nature Conservancy)	This topic is widely covered in chapter 5, and included within the list of ecosystem services and is approached in section 6.4.1.3.
665	72453	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)	This section is now revised, the discussion of uncertainties has been dropped.
666	58534	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; (Janice Lough, Australian Institute of Marine Science)	The section deals with global fish production.
667	56562	6	41	16	0	0	Should it be "75 and 85 million tonnes per year" (Archis Ambulkar, Brinjac Engineering Inc.)	Agreed and time line added.
668	82070	6	41	21	41	21	The chapter team could consider placing "high confidence" within parentheses at the end of the statement. (Katharine Mach, IPCC WGII TSU)	Agreed and amended.
669	64473	6	41	25	0	0	Change reference from (Sebatés et al., 2006) to (Sebatés et al., 2006; Jansen et al., 2012) (Teunis Jansen, Danish Technical University - National Institute of Aquatic Resources)	Thanks for the suggestion, we found no need to provide more references for this pont.
670	79476	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)	The MPA narrative is not included here, but dealt with in the fisheries-related risks table.
671	59935	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)	Agreed and amended.
672	57787	6	41	32	41	32	Somewhere near here define OA again for the reader. (Ronald Stouffer, Geophysical Fluid Dynamics Laboratory/NOAA)	Done
673	72454	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)	Attended, reference removed from that paragraph, links to cross chapter box established.
674	65803	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. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We have included the reference.
675	56286	6	41	43	0	0	change "effect" to "affect" (Elizabeth Mcleod, The Nature Conservancy)	Sentence and section has been restructured, detail lost.
676	57251	6	41	43	41	43	"effect" should be "affect" (Erica Head, Fisheries and Oceans Canada)	Sentence and section has been restructured, detail lost.
677	82071	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? (Katharine Mach, IPCC WGII TSU)	The text has been revised to clarify this.
678	59936	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)	Sentence has been rephrased for improved clarity.
679	79477	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)	Thanks for the recommendation. There is now a full CC box dealing with OA, including costs. We have included this reference.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
680	56736	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 (JOSEP LLORET, UNIVERSITY OF GIRONA)	We agree, but there is a strong limitation on page numbers and we are committed to balance the sections. Therefore, we did not see a way to include this reference. We have to focus on aspects clearly affected by climate change.
681	57252	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)." (Erica Head, Fisheries and Oceans Canada)	agreed and amended
682	57253	6	42	14	42	15	The phrase "newly open previously uninhabitable areas as peak seasons shift" is unclear and needs re-writing - I don't know what the authors are trying to say. (Erica Head, Fisheries and Oceans Canada)	Agreed and amended.
683	57788	6	42	16	42	17	stable levels of atmospheric CO2 level - Stable? BY most measures, glacial-interglacial CO2 levels are not stable. Reword. (Ronald Stouffer, Geophysical Fluid Dynamics Laboratory/NOAA)	Words deleted to avoid confusion.
684	72455	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)	Words deleted to avoid confusion.
685	72456	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)	Agreed, text substantially modified and refs included. (This comment seems to be meant for page 43, line 17)
686	82072	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." (Katharine Mach, IPCC WGII TSU)	Agreed and amended.
687	58450	6	42	21	42	21	The organic carbon biological pump and the CaCO3 counter-pump (Martin Pecheux, Institut des Foraminifères Symbiotiques)	In the chapter we have focused on the biological pump (figure 6.4 and Table 6.1) to illustrate the complexity of this vector for sinking carbon. There was not sufficient space to also illustrate this complexity for the calcite counter-pump.
688	82073	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." (Katharine Mach, IPCC WGII TSU)	Agreed, attended through the entire chapter.
689	58250	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 (Ricardo Anadon, University of Oviedo)	the section has been shortened and the reader is referred to chapter 5
690	82074	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. (Katharine Mach, IPCC WGII TSU)	The sentence has been deleted and the effect of healthy ecosystems on regulation has been emphasised
691	56287	6	42	45	0	0	what is reference "(SREX)? (Elizabeth Mcleod, The Nature Conservancy)	We have added IPCC 2012 to the SREX citation "Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation" to clarify matters.
692	56288	6	42	45	0	0	suggest changing "natural ocean structures and organisms" to "coastal and marine habitats" or "coastal and marine ecosystems" (Elizabeth Mcleod, The Nature Conservancy)	Sentence and section has been restructured, detail lost.
693	56563	6	42	45	0	0	Term SREX needs to be defined in this sentence i.e. its long form. (Archis Ambulkar, Brinjac Engineering Inc.)	Long title to be found in the reference list.
694	72457	6	42	45	42	45	Please define SREX. (UNITED STATES OF AMERICA)	Long title to be found in the reference list.
695	72458	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)	Sentence and section has been restructured, detail lost.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
696	61109	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. (European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)	The CC-CR box approaches these topics in depth. We have cross-referenced to the CC box to facilitate readability.
697	82075	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. (Katharine Mach, IPCC WGII TSU)	Agreed and amended.
698	79478	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)	Agreed and amended, included under new 6.4.1.4.
699	65804	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 Airoldi et al., 2005, Martins et al., 2005; Moschella et al., 2005; Firth et al., 2013 (in press) Airoldi 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, Airoldi 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 (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	This is an interesting point, but the topic belongs clearly to Chapter 5, with a special focus on sea level rise impacts and potential adaptations.
700	57254	6	44	3	44	3	This should be "Human societies benefit from and depend on marine ecosystem services" (Erica Head, Fisheries and Oceans Canada)	Agreed and amended.
701	82076	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. (Katharine Mach, IPCC WGII TSU)	Agreed and amended.
702	57592	6	44	9	0	0	"affects" (George Somero , Stanford University)	Sentence and section has been restructured, detail lost.
703	58251	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. (Ricardo Anadon, University of Oviedo)	The text in section has changed substantially. We found no way to attend this comment anymore.
704	57255	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)." (Erica Head, Fisheries and Oceans Canada)	This sentence is now removed from the text during revision and thus the comment is no longer relevant.
705	61110	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). (European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)	This point regarding climate regulation is now highlighted in the first paragraph of ES.
706	58451	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) (Martin Pecheux, Institut des Foraminifères Symbiotiques)	Alkalinity pump has been added.
707	56289	6	44	44	0	0	what does "increased variability of ecosystems" refer to? Variability of ecosystem response to climate change? Need to clarify this. (Elizabeth Mcleod, The Nature Conservancy)	Yes, the background of this variability has been explained in the previous paragraph.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
708	56290	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'." (Elizabeth Mcleod, The Nature Conservancy)	We are tight on space, but found a way to include this reference in the Ecosystem management section.
709	58942	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 (Chris Vivian, IMAREST)	We are tight on space, have reported on the ecosystem impacts of the major approaches, and we do not see to include further detailed discussions on this topic.
710	80390	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. (Gian-Kasper Plattner, IPCC WGI TSU)	Agreed and amended.
711	56564	6	45	6	0	0	Term SRM is already defined on Page 5, line 38. (Archis Ambulkar, Brinjac Engineering Inc.)	It appears useful to repeat the definition in the relevant section.
712	57256	6	45	6	45	6	I think "Reduction" should be replaced by "Removal" (Erica Head, Fisheries and Oceans Canada)	Agreed and amended.
713	68891	6	45	6	45	6	CDR: Is general referred as Carbon Dioxide Removal (in geoengineering terms). (NETHERLANDS)	Agreed and amended.
714	61111	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". (European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)	Agreed and amended.
715	63513	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)	Agreed and amended.
716	57495	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." (Alexey Ryaboshapko, Institute of Global Climate and Ecology)	Agreed and amended.
717	57496	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.]. (Alexey Ryaboshapko, Institute of Global Climate and Ecology)	We want to keep the more recent and up to date Crutzen 2006 and therefore can't include the suggested reference as we cannot provide a full scope review.
718	61112	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). (European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)	Agreed and amended.
719	65056	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. (Action Group on Erosion, Technology and Concentration (ETC Group))	Half-sentence removed as this means a combination of SRM and CDR techniques.
720	57497	6	45	10	45	10	"OA are left unabated..." See the comment to (Chapter 5, Page 50, Lines 26-28) (Alexey Ryaboshapko, Institute of Global Climate and Ecology)	The present writing emphasizes the goal of SRM techniques but also their inability to do something significant about mitigating ocean acidification.
721	57498	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? (Alexey Ryaboshapko, Institute of Global Climate and Ecology)	Formulation has been changed to indicate the risk element in termination which does not exist for CDR.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
722	61113	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). (European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)	Not that we are aware of.
723	58452	6	45	14	45	16	Table 6-10: Sequestration of organic carbon: Storage of crop residue or wood biomass...Physical impact...H2S, 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. (Martin Pecheux, Institut des Foraminifères Symbiotiques)	We did not see a way or need to include further references on this, due to similar environmental impacts.
724	56565	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. (Archis Ambulkar, Brinjac Engineering Inc.)	Agreed and amended.
725	58453	6	45	19	45	19	(Table 6-10; IPCC 2005; Williamson... (Martin Pecheux, Institut des Foraminifères Symbiotiques)	References rearranged.
726	56566	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. (Archis Ambulkar, Brinjac Engineering Inc.)	HNLC mentioned for the first time here.
727	58943	6	45	33	0	36	This sentence 's conclusion that CO2 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. (Chris Vivian, IMAREST)	Agreed and amended.
728	58454	6	45	36	45	36	However, part of the CO2 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. (Martin Pecheux, Institut des Foraminifères Symbiotiques)	This provides too much detail for the space we can allocate in this chapter to geoengineering. Any biomass storage exacerbates hypoxia.
729	57257	6	45	42	45	42	HABs are mostly "natural phenomena" NOT "a natural phenomenon" (Erica Head, Fisheries and Oceans Canada)	Sentence and section has been restructured, detail lost.
730	58456	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. (Martin Pecheux, Institut des Foraminifères Symbiotiques)	Fu et al. has been added.
731	56567	6	45	49	0	0	Should be "HABs" instead of "HABS" (Archis Ambulkar, Brinjac Engineering Inc.)	Agreed and amended.
732	58455	6	45	49	45	49	Add: ...Dave et al 2006). Although there are indication that harmful algae are "CO2-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, CO2 control on carbon-isotope fractionation during aqueous photosynthesis: a paleoCO2 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 dinoflagellates blooms. Developpement 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. (Martin Pecheux, Institut des Foraminifères Symbiotiques)	We have updated this section with several recent papers on this topic - such as Tatters et al. (2013) and Sun et al. (2011).
733	79479	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)	Insufficient space and sufficient coverage of this topic by citations in this section.
734	72459	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)	Rephrased. The record was used to show the relationship with ENSO events.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
735	56568	6	46	11	0	0	Term ENSO is already defined in the chapter. (Archis Ambulkar, Brinjac Engineering Inc.)	ENSO defined on first mention and not repeatedly.
736	79480	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)	Due to constraints in space we did not see a way to include this reference.
737	82077	6	46	16	46	16	The chapter team could consider presenting a summary term for agreement here as well. (Katharine Mach, IPCC WGII TSU)	Confidence level expressed.
738	82078	6	46	29	46	29	The chapter team could consider presenting "high confidence" within parentheses at the end of the statement. (Katharine Mach, IPCC WGII TSU)	Confidence level moved to end of sentence.
739	82079	6	46	36	46	36	The chapter team could consider presenting a summary term for agreement here as well. (Katharine Mach, IPCC WGII TSU)	Confidence level expressed.
740	56291	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. (Elizabeth Mcleod, The Nature Conservancy)	We cannot provide exhaustive list of references because of page limit. The currently cited references already provide sufficient support for the statement.
741	65805	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. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We cannot provide an exhaustive list of references because of page limits. The currently cited references already provide sufficient support for the statement.
742	80391	6	46	53	46	53	Please provide a specific referent to WGI. (Gian-Kasper Plattner, IPCC WGI TSU)	A specific section (Ch9 9.8) is now cited.
743	80723	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. (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	The reference is now added.
744	61114	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. (European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)	The reference is now added on p 43.
745	58252	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 problaby affect to the whole pelagic community. I suugest to introduce a short paragraph in these sense. (Ricardo Anadon, University of Oviedo)	We concur. The topic is now mentioned (see comment 744).
746	58253	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 (Ricardo Anadon, University of Oviedo)	The reference is now changed.
747	72460	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)	Amended
748	58457	6	47	18	47	19	Put in the riht order, from 2.6 to 8.5. And 2100, not 2990s. (Martin Pecheux, Institut des Foraminifères Symbiotiques)	The order and timeframe noted in the text are correct.
749	58458	6	47	35	47	39	Fig 6-14. Gives names and references of the four models. (Martin Pecheux, Institut des Foraminifères Symbiotiques)	This section has been updated and the comment is no longer relevant.
750	72461	6	47	42	47	42	This section needs confidence limits on these statements. (UNITED STATES OF AMERICA)	The paragraphs provide evidence, while uncertainty statements based on these evidence are given in the conclusion section.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
751	65308	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. (Shin-ichi Ito, Fisheries Research Agency, Tohoku National Fisheries Research Institute)	We included Ito et al 2010, but did not see a way to include the other references due to page limit. The complexity of influences is a major focus of our assessment.
752	72462	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)	The meaning is correct. The text has been revised to clarify the meaning.
753	79481	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)	Caption of what is now Figure 6-14 has been revised for increased clarity.
754	58459	6	48	8	48	16	Fig 6-15 B Shift in latitudinal centroid 23 km not 23 m. (Martin Pecheux, Institut des Foraminifères Symbiotiques)	This is now corrected.
755	65618	6	48	8	48	16	Fig. 6-15. Median = 23 km/decade. (Sukgeun Jung, Jeju National University)	This is now corrected.
756	82080	6	48	19	48	19	It would be preferable to specify the "main assumptions" mentioned, given the visibility of the corresponding findings. (Katharine Mach, IPCC WGII TSU)	Key assumptions are now stated in the caption of the figure.
757	58460	6	48	20	48	20	under RCP2.5 as well There is already a long-term decline. (Martin Pecheux, Institut des Foraminifères Symbiotiques)	The decline is now include RCP 2.6.
758	82081	6	48	20	48	20	RCP 3 should be 2.6. (Katharine Mach, IPCC WGII TSU)	This is now revised.
759	58461	6	48	23	48	23	...to be most threatened, if still exist,... (Martin Pecheux, Institut des Foraminifères Symbiotiques)	We do not think that the qualifier of "if still exist" is needed.
760	79482	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)	The reference by Huntley is now added.
761	72463	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)	Bycatch is now mentioned in the section.
762	82082	6	48	44	48	44	Here it would be preferable to specify the relevant subsections of chapter 7. (Katharine Mach, IPCC WGII TSU)	Specific section in Ch. 7 is now cited.
763	65039	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 (George Hunt, University of Washington)	See response to comments on ES.
764	63221	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. (Keith Brander, Technical University of Denmark)	I think Chapter 5 mis-quoted the original paper. The original paper state that some coastal Indian Ocean has the slowest rate of warming, with increase in catch. But the increase in catch is largely driven by more intensive fishing. There is no attribution of changes in catch to climate/warming effects.
765	79483	6	49	19	49	19	It should read "Mollusc fisheries and aquaculture are projected to be...." (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)	Text has been heavily edited.
766	82083	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. (Katharine Mach, IPCC WGII TSU)	Text has been heavily edited.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
767	82084	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. (Katharine Mach, IPCC WGII TSU)	Text and content have been heavily edited.
768	82085	6	49	52	49	54	The chapter team could consider presenting "high confidence" within parentheses for the statements. (Katharine Mach, IPCC WGII TSU)	Text and content have been heavily edited.
769	82086	6	49	53	49	53	Will there be no changes in the rates of shifts as compared to the last century? (Katharine Mach, IPCC WGII TSU)	Text and content have been heavily edited.
770	66254	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. (Geir Ottersen, Institute of Marine Research)	The acronyms emphasize our efforts to link text and figure. We have now deemphasized their use in text and figure but still believe in their usefulness for those looking for these clear links, in line with previous review comments received. We have checked but as we are not assigning confidence to the underlying physical climate change processes, strong reference to WGI is not really appropriate here, in contrast to 6.1.1.
771	82087	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? (Katharine Mach, IPCC WGII TSU)	We have set up a risk table for marine risks that is balanced with the other marine chapters. This table also distinguishes the near from the long term. We have also modified the text where appropriate to take this into account.
772	72464	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)	Altered to reflect this microbial trend.
773	82088	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. (Katharine Mach, IPCC WGII TSU)	We have set up a risk table for marine risks that is balanced with the other marine chapters. This table also distinguishes the near from the long term. We have also modified the text where appropriate to take this into account.
774	79484	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)	We have set up a risk table for marine risks that is balanced with the other marine chapters. This table also distinguishes the near from the long term. We have also modified the text where appropriate to take this into account.
775	82089	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. (Katharine Mach, IPCC WGII TSU)	The text and caption have been rephrased to clarify the use of the terms, including attribution.
776	80392	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. (Gian-Kasper Plattner, IPCC WGI TSU)	The acronyms emphasize our efforts to link text and figure. We have now deemphasized their use in text and figure but still believe in their usefulness for those looking for these clear link, in line with previous review comments received. We have checked but as we are not assigning confidence to the underlying physical climate change processes, strong reference to WGI is not really appropriate here, in contrast to 6.1.1.
777	72465	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)	The acronyms emphasize our efforts to link text and figure. We have now deemphasized their use in text (where they are in fact spelled out) and figure but still believe in their usefulness for those looking for these clear link, in line with previous review comments received.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
778	58462	6	50	53	50	53	...300 Ma apart the Cretaceous/Tertiary boundary (Martin Pecheux, Institut des Foraminifères Symbiotiques)	See comments above.
779	61115	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." (European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)	In light of the findings of WGI we have changed our confidence level to medium. While we are highly confident of the biotic reaction if the change would happen, the confidence in the expansion is less
780	82090	6	51	21	51	21	The chapter team could consider presenting "medium confidence" within parentheses at the end sentence. (Katharine Mach, IPCC WGII TSU)	This has been done in most cases.
781	72466	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)	This is reportedly an observation in OMZs.
782	65806	6	51	28	51	28	delete "e.g. through" and re place with "an example being" (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Formulation has been replaced.
783	80725	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. (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	The text makes clear that present field evidence of effects of OA is still poor (due to reasons discussed there). However, the projection of future effects relies on laboratory findings and observations in field experiments and at natural analogues (which are not seen as part of the normal field). This should explain the differences and is now emphasized more in this section.
784	72467	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)	This point has been considered.
785	80726	6	52	7	0	0	May be that should include viruses? (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	Text has been rephrased.
786	72468	6	52	13	52	13	This sentence is not comprehensible. Please clarify. (UNITED STATES OF AMERICA)	Deleted
787	82091	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. (Katharine Mach, IPCC WGII TSU)	The text has been deleted.
788	82092	6	52	15	52	16	The chapter team could consider presenting "low confidence" within parentheses at the end of the sentence. (Katharine Mach, IPCC WGII TSU)	Checked throughout the text.
789	56569	6	52	21	0	0	Term NPP is already defined on Page 4, line 32. (Archis Ambulkar, Brinjac Engineering Inc.)	Given that this is a long time ago, we would like to repeat the definition here.
790	58758	6	52	24	52	28	This statement is closer to correct and does not support the summary statement p19 line 29. (Connie Lovejoy, Université Laval)	The NPP part has been completely rewritten and discussion in a cross chapter box to give the complexity of the problem a detailed assessment.
791	65807	6	52	34	52	54	Herring to Pilchard (sardine) in English Channel (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	There are a large number of examples possible and we have selected a few which does not include this example.
792	79485	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)	The literature suggests consensus that there is a shift in distribution of North Atlantic cod (thus high confidence in detection), although the underlying reasons for the shift may due to reasons other than warming. Also, there are regional uncertainties, dependig on the complexity of environmental change. However, available evidence suggest that temperature change is one of the main drivers affecting cod distribution (thus medium confidence in attribution).
793	82093	6	52	43	52	43	Instead of "causes," it would be clearer to say "has caused." (Katharine Mach, IPCC WGII TSU)	Has been modified appropriately.
794	59937	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)	Thank you

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
795	58463	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) (Martin Pecheux, Institut des Foraminifères Symbiotiques)	Work in prep cannot be included in the assessment which is based on a large body of evidence on the effects of temperature and OA.
796	61116	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. (European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)	Aren't key uncertainties at the same time recommendations for future efforts to clarify? But certainly, any limitation in confidence asks for such clarification.
797	65619	6	53	26	53	45	The paragraph here seems to address limitations of current science, rather than "Key Uncertainties". (Sukgeun Jung, Jeju National University)	Aren't key uncertainties at the same time recommendations for future efforts to clarify? But certainly, any limitation in confidence asks for such clarification.
798	72469	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)	When revisiting this issue we found it overstated as some scaling has in fact been successful but has not been widely implemented. This is now stated more clearly.
799	79486	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)	We appreciate this advice and share the conclusions of the paper but have not added any citations to the summary parts as a principle. This reference is now included in the modeling section.
800	71293	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)	FAQs have been revised and edited carefully.
801	72470	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)	FAQs are generally included as part of the IPCC assessments.
802	71294	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)	Now stated as 'oceans and their ecosystems'.
803	81237	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. (Monalisa Chatterjee, IPCC WGII TSU)	All FAQs have been reworded.
804	82094	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. (Katharine Mach, IPCC WGII TSU)	All FAQs have been reworded, phrase was lost.
805	80730	6	53	50	55	48	The replies to the frequently asked questions are much too long. (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	FAQs have been carefully edited and shortened.
806	58464	6	53	51	53	51	71% (in fact 70.8%) (Martin Pecheux, Institut des Foraminifères Symbiotiques)	Agreed and amended.
807	72471	6	53	51	53	51	This statement will lead to confusion "The life they contain creates about half of the oxygen (O ₂) we breathe" Human oxygen consumption is insignificant on global scale and most of marine O ₂ production is consumed locally (in the ocean) (UNITED STATES OF AMERICA)	Human O ₂ consumption is indeed a very small part of global respiration. The point here is that the O ₂ in the atmosphere derives about half from terrestrial plants and the other half from ocean phytoplankton.
808	72472	6	53	52	53	53	The following statement can be misinterpreted. Most of the CO ₂ uptake is converted into inorganic carbon NOT into organic carbon as stated. "Oceans currently absorb ~25 % of the carbon dioxide (CO ₂) 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)	We revised this sentence.
809	65621	6	54	6	54	14	I think it is better to delete the phrase "but difficult". (Sukgeun Jung, Jeju National University)	We removed "but difficult".
810	65620	6	54	15	54	24	This paragraph seems irrelevant to the question. (Sukgeun Jung, Jeju National University)	We revised the entire FAQ 6-1, and made the context more clear.
811	58465	6	54	21	54	21	is almost unprecedented (cf the K/T) (Martin Pecheux, Institut des Foraminifères Symbiotiques)	We have added a qualifier to the modified text.
812	71295	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)	We no longer use the word special.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
813	81238	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. (Monalisa Chatterjee, IPCC WGII TSU)	FAQ titles have changed.
814	58466	6	54	31	54	31	...less alkaline, with more proton H+ concentration) (Martin Pecheux, Institut des Foraminifères Symbiotiques)	Here and for most of the FAQ comments- we have changed, revised, edited and otherwise improved the FAQs to accommodate reviewer comments.
815	57258	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? (Erica Head, Fisheries and Oceans Canada)	Here and for most of the FAQ comments- we have changed, revised, edited and otherwise improved the FAQs to accommodate reviewer comments.
816	61117	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 (European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)	Here and for most of the FAQ comments- we have changed, revised, edited and otherwise improved the FAQs to accommodate reviewer comments.
817	71296	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)	Here and for most of the FAQ comments- we have changed, revised, edited and otherwise improved the FAQs to accommodate reviewer comments.
818	72473	6	54	50	0	0	This FAQ question is awkwardly worded. "What" instead of "How" ? (UNITED STATES OF AMERICA)	Here and for most of the FAQ comments- we have changed, revised, edited and otherwise improved the FAQs to accommodate reviewer comments.
819	81239	6	54	50	0	0	FAQ 6-3 The FAQ answer is very academic. The language needs to be simplified for a wider audience. (Monalisa Chatterjee, IPCC WGII TSU)	Here and for most of the FAQ comments- we have changed, revised, edited and otherwise improved the FAQs to accommodate reviewer comments.
820	82095	6	54	50	54	50	"what" instead of "how" might make for better idiom here. (Katharine Mach, IPCC WGII TSU)	FAQ titles have changed.
821	79487	6	55	11	55	11	After...."species richness" insert the phrase "at some sites." (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)	This would be misleading as this is an overall trend and not confined to certain sites. We now say "within some marine communities" to indicate the patchiness.
822	79488	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)	This text has been revised in final.
823	71297	6	55	23	0	0	"sufficiently alkaline" will not be understood by a general audience. More simple wording is needed for the FAQ and the concept should be better explained in the response. (CANADA)	expression has been lost during revisions.
824	80727	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. (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	FAQ from SOD has been deleted.
825	81240	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. (Monalisa Chatterjee, IPCC WGII TSU)	deleted
826	58467	6	55	27	55	27	Add: Magnesium calcite (lager foraminifera) is even more soluble. (Martin Pecheux, Institut des Foraminifères Symbiotiques)	deleted
827	80728	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. (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	deleted
828	58468	6	55	31	55	31	If high CO2 levels or high H+ proton levels from outside (Martin Pecheux, Institut des Foraminifères Symbiotiques)	deleted
829	79489	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)	deleted
830	80729	6	55	44	55	48	This does not seem to address the question (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	deleted
831	56292	6	56	10	0	0	suggest adding "livelihoods" as well under "provisioning" services (Elizabeth Mcleod, The Nature Conservancy)	Agreed and added to 6.4.1, 6.5.3, and 6.6.1.
832	72474	6	56	11	56	11	Oxygen supply from reefs is completely insignificant, delete: "supporting services (oxygen supply)" (UNITED STATES OF AMERICA)	deleted

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
833	72475	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)	We agree and have modified the text accordingly - mentioning only thermal stress in the opening parts of this paragraph referring to since the 1980s.
834	56293	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 (Elizabeth Mcleod, The Nature Conservancy)	The text has been modified accordingly.
835	79490	6	56	16	56	16	The text should read " the most important and pervasive environmental variables". (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)	see reply to #945 to chapter 30.
836	57259	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." (Erica Head, Fisheries and Oceans Canada)	see reply to #946 to chapter 30.
837	72476	6	56	25	56	25	Reference to figure "5X" needs to be updated with the appropriate figure number. (UNITED STATES OF AMERICA)	Yes.
838	56294	6	56	29	0	0	suggest adding 'reef-dependent' so it reads: "changes will erode reef-dependent fish habitats" (Elizabeth Mcleod, The Nature Conservancy)	The text has been modified accordingly.
839	72477	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)	This report, actually published in 2011, is very interesting but we do not see the need add its reference as it does not provide a firm conclusion as to whether 83 coral species should be listed as threatened or endangered under the U.S. Endangered Species Act: "This document makes no recommendations for listing, as that is a separate evaluation to be conducted by the NMFS".
840	72478	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)	The text has been modified accordingly.
841	56295	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)..... (Elizabeth Mcleod, The Nature Conservancy)	The text has been modified accordingly.
842	56296	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. (Elizabeth Mcleod, The Nature Conservancy)	We agree but could only add part of the suggested text due to space constraints.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
843	56297	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. (Elizabeth Mcleod, The Nature Conservancy)	We agree but could only add part of the suggested text due to space constraints.
844	60660	6	58	0	0	0	Box OA appears to have been duplicated in both chapters 5 and 6. (Haroon Kheshgi, ExxonMobil Corporate Strategic Research)	The cross-chapter boxes are included in all participating chapters. This is an editorial decision of the WG2 TSU.
845	79491	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)	The cross-chapter boxes are included in all participating chapters. This is an editorial decision of the WG2 TSU.
846	72479	6	59	13	59	13	Reference to figure WGII, Figure 6.28 should actually be WGI, Figure 6.28. (UNITED STATES OF AMERICA)	The text has been corrected accordingly.
847	79492	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)	The text has been corrected accordingly.
848	72480	6	59	29	59	29	What are "ecosystem builders"? Avoid use of jargon (UNITED STATES OF AMERICA)	Replaced by "ecosystem engineers" which is presumably less jargon and has a wikipedia entry.
849	79493	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)	This is addressed a little further in the box (p. 65 of the SOD, line 36 onwards).
850	57499	6	60	33	60	35	See the comment to (Chapter 5, Page 50, Lines 26-28) (Alexey Ryaboshapko, Institute of Global Climate and Ecology)	See reply to comment #1147 on chapter 5.
851	79494	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)	We have not chosen to incorporate this perspective because space is very strictly limited.
852	80717	6	80	34	0	0	The publication date of Joint et al. is 2011 (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	Amended
853	64238	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)	This reference is now included in the Box on the North Atlantic.
854	59939	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)	We have deleted the table due to space constraints.
855	65808	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. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We have deleted the table due to space constraints.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
856	72481	6	124	0	0	0	Table 6.1: Include confidence or likelihood assessment in the interpretation. (UNITED STATES OF AMERICA)	We have deleted the table due to space constraints.
857	82096	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? (Katharine Mach, IPCC WGII TSU)	We have deleted the table due to space constraints.
858	79495	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)	We have deleted the table due to space constraints.
859	82097	6	125	0	0	0	Table 6-2. The chapter team should consider deleting this textbook-like table. (Katharine Mach, IPCC WGII TSU)	We have deleted the table due to space constraints.
860	79496	6	125	0	125	0	Can't quite see what this table (Table 6-2) adds (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)	We have deleted the table due to space constraints.
861	72482	6	126	0	0	0	Table 6.3: Specify approximate latitude ranges of Southern Ocean and low latitude gyre. (UNITED STATES OF AMERICA)	We have deleted the table due to space constraints.
862	81385	6	126	0	0	0	Table 6-3: "Degree of" what? (Yuka Estrada, IPCC WGII TSU)	We have deleted the table due to space constraints.
863	81386	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. (Yuka Estrada, IPCC WGII TSU)	We have synchronized this table with the corresponding figure, now fig 6-4.
864	66247	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). (Cornelia Maier, Laboratoire d'Océanographie de Villefranche sur Mer)	We have now separated between cold- and warm-water corals in table 6-3.
865	72483	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)	We have specified in present Table 6-3: It should be noted that anthropogenic CO ₂ accumulation according to RCP scenarios adds to the natural variability of CO ₂ concentrations in marine environments.
866	82098	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? (Katharine Mach, IPCC WGII TSU)	References for Table 6-5 (now 6-3) are in an extra reference list, to be found online. The time line of projections results from the CO ₂ range covered and is specified for RCPs and 2100 now. However, it is a good suggestion to include it in the header of the column as well.
867	80685	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) pCO ₂ 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). (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	(1) We have removed table 6-6 as overly detailed in relation to the conclusions supported, and transferred the content either to the text, or included in table 6-5 (now 6-3). (2) References for Table 6-5 (now tab 6-3) are in an extra reference list. (3) expert judgement is a valid approach. Here, the classification is not by judgement but following clear criteria. Beneficial or detrimental are now clearly defined. Statistics do not always help. We feel this approach complements other existing analyses such as Kroeker et al., 2013, which is well represented in the chapter and crosschapter box CC-OA. In table 6-3, we relate to CO ₂ levels more than pH. For the treatment of partial pressure see earlier comment. The remaining table uses μatm as requested.
868	72484	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)	We have removed this table as overly detailed in relation to the conclusions supported, and transferred the content either to the text, or included in table 6-5 (now 6-3).

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
869	72485	6	129	0	0	0	Table 6.6: Include assessment of confidence. (UNITED STATES OF AMERICA)	We have removed this table as overly detailed in relation to the conclusions supported, and transferred the content either to the text, or included in table 6-5 (now 6-3).
870	61118	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). (European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)	We have removed this table as overly detailed in relation to the conclusions supported, and transferred the content either to the text, or included in table 6-5 (now 6-3).
871	67860	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)	We have merged tables 6-7 and 6-8, condensed information and included new information if appropriate (now table 6-2) The information has been changed as suggested.
872	72486	6	131	0	0	0	Table 6.7 seems very incomplete. Please check recent literature for additional examples. (UNITED STATES OF AMERICA)	We have merged tables 6-7 and 6-8, condensed information to illustrate selected examples. We have included new information if appropriate (now table 6-2)
873	72487	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)	The reference to what is now figure 6-10 B has been corrected.
874	82099	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. (Katharine Mach, IPCC WGII TSU)	We have merged tables 6-7 and 6-8, condensed information and included new information if appropriate (now table 6-2). We have added timelines where useful as several examples are about identifying mechanisms.
875	79497	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)	We have merged tables 6-7 and 6-8, condensed information and included new information if appropriate (now table 6-2). These are selected examples identifying mechanisms. The larger picture is provided by the new crosschapter box on biogeography.
876	65809	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. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	This table is now deleted and thus the comment is no longer relevant.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
877	72488	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)	This table is now deleted and thus the comment is no longer relevant. (This comment seems to be meant for page 145)
878	72489	6	133	0	0	0	Table 6.8: Include an assessments of confidence. (UNITED STATES OF AMERICA)	This table is now deleted and thus the comment is no longer relevant.
879	82100	6	133	0	0	0	Table 6-8. The timeframe for all examples of observed changes within this table should be specified. (Katharine Mach, IPCC WGII TSU)	This table is now deleted and thus the comment is no longer relevant.
880	79498	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)	This table is now deleted and thus the comment is no longer relevant.
881	65810	6	134	0	0	0	Table 6-8. "Phenology" Warming did not really kick off until 1987 around the UK. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	This table is now deleted and thus the comment is no longer relevant.
882	65811	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. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	This table is now deleted and thus the comment is no longer relevant.
883	72490	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)	This table is now deleted and thus the comment is no longer relevant. (This comment refers to table 6-8)
884	65812	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. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We have checked the suggested references, some are cited but due to our focu on open oceans we could not add these to the table due to space constraints
885	72491	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)	We now assure the correct referencing in the flow of the text.
886	72492	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)	We have revised this table and the caption and removed the offending "??".
887	82101	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? (Katharine Mach, IPCC WGII TSU)	We have revised this table and the caption and removed the offending text.
888	64239	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)	We have revised this table and the caption and removed the offending text.
889	63514	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)	We have revised the connected chapter text.
890	72493	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)	We now assure the correct use of letter divisions in the new figure version.
891	72494	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)	There is insufficient space in this table to list all of the proposed or planned geoengineering methods, hence we have had to restrict it to illustrative examples of SRM and CDR approaches.
892	79956	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)	amended
893	72495	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)	We have removed this figure from the chapter. However, it is now included in a Cross-Chapter box on primary production, and addresses the mentioned issues.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
894	81382	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. (Yuka Estrada, IPCC WGII TSU)	We have removed figure 6-1 from the chapter. However, it is now included in a Cross-Chapter box on primary production, and now present it in Robinson projection. Also maps in former fig 6-2 are now in the correct projection.
895	57530	6	138	0	0	0	Fig.6-2A\B There is a mistake on °C (Siyuan Ye, Qingdao institute of marine geology)	Yes, thank you. We have corrected this typo.
896	68086	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)	We have revised the figure accordingly.
897	72496	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)	Both the figure and its legend have been revisited, simplified and revised for clarity.
898	82102	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. (Katharine Mach, IPCC WGII TSU)	Colors in part A where modified attending this suggestion. Panel D has changed, together with the figure caption.
899	57593	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. (George Somero , Stanford University)	We have revised figure and figure caption to make it more clear.
900	72497	6	139	0	0	0	Figure 6.3: Extinction axis label is confusing because axis is not extinction. Please clarify. (UNITED STATES OF AMERICA)	We added the label number of species to show extinction within the biota.
901	81383	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. (Yuka Estrada, IPCC WGII TSU)	We have moved the panel to make the data more comparable, We have changed the figure caption, We have explained the difference between the two temperature records, We explained the colour selection , We cannot avoid an overlap of X axes due to space constraints but tried to make the information more accessible.
902	82103	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. (Katharine Mach, IPCC WGII TSU)	We have revised the figure, and made it more clear. Moreover, caption has been revised.
903	79499	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)	We have revised the figure and figure caption, and made it clearer, we have deleted to reference to locations as these are less relevant in this context.
904	72498	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)	We have removed this figure, comment does not apply any more.
905	81384	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? (Yuka Estrada, IPCC WGII TSU)	We have removed this figure, comment does not apply any more.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
906	82104	6	140	0	0	0	Figure 6-4. As a minor point, the acronym MLD should be spelled out in the caption at least. (Katharine Mach, IPCC WGII TSU)	We have removed this figure, comment does not apply any more.
907	79500	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)	We have removed this figure, comment does not apply any more.
908	81387	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. (Yuka Estrada, IPCC WGII TSU)	We have revised the figure and now assure a better linking with corresponding table.
909	72499	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)	We improved the figure and rewrote and restructured the figure legend.
910	82105	6	143	0	0	0	Figure 6-7. The labeling of the spring warming cue could be clarified in part C. (Katharine Mach, IPCC WGII TSU)	The labeling has been explained in the legend.
911	81388	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. (Yuka Estrada, IPCC WGII TSU)	We improved the figure and rewrote and restructured the figure legend.
912	57594	6	147	0	0	0	Legend to Figure 6-9: "resident" biota (George Somero , Stanford University)	We have revised the figure caption.
913	61937	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. (Dag Lorents Aksnes, University of Bergen)	We have revised the figure, figure caption and connected chapter text in order to clarify
914	80696	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. (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	This indeed is a vexing issue centring on the widespread use of the term Ocean acidification (OA) even though the oceans will remain alkaline as defined by the pH scale. Given the widespread use of the term OA we think it would be justified to retain this term ("acidic") but have now said more acidified in the figure to avoid misunderstandings and have also altered the text to clarify what this will mean in terms of pH units and that the ocean is still alkaline.
915	81389	6	147	0	0	0	Figure 6-9: This is a very effective use of visual presentation of the information provided. But what does "fresher" really mean? Also, please clarify what the white solid and dashed lines are illustrating. (Yuka Estrada, IPCC WGII TSU)	The meaning of 'fresher' is detailed in subsection "6.1.1.1 Temperature and salinity". The dashed and solid lines have been defined.
916	82106	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. (Katharine Mach, IPCC WGII TSU)	We have revised the figure caption and the chapter text.
917	85207	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. (Vincent Gray, Climate Consultant)	This is a schematic showing the principal processes. We would like to keep it simple in order not to confuse readers. For information on regional variability see Chapter 30.
918	59938	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)	This figure has been revised and should be more clear now.
919	80697	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. (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	This figure has been revised to illustrate the general mechanisms which are important to consider when elaborating unifying principles.
920	80698	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). (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	The work by Kroeker et al. has always been considered. The chapter text has been revised, and the literature has been updated (e.g. including Kroeker et al 2013). Kroeker et al is strongly emphasized in the OA Box, with respect to its biogeochemical implications. We complement this approach by adding information on sensitivities across organism groups.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
921	80699	6	148	0	0	0	Fig. 6-10B: almost half of the bars (those above 1370 μatm) have no environmental relevance for the present century, hence with this chapter, and should be removed. (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	To illustrate the underlying principles (see above) we include the full titration curve and thereby continuity of effects between low and high CO ₂ . It also needs to be considered that climate change does not stop in 2100 but only when the planet has reached equilibrium. So CO ₂ levels may well reach higher in the future and they are also higher in CO ₂ -rich natural environments.
922	82107	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?? (Katharine Mach, IPCC WGII TSU)	This figure has been heavily revised and made clearer.
923	79501	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)	We have adjusted the figure, caption and text. Meanwhile, this meta analysis is published
924	57531	6	150	0	0	0	Fig.6-11: The latitude scale is not correct (Siyuan Ye, Qingdao institute of marine geology)	We have revised this figure.
925	79502	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)	We have revised this figure.
926	72500	6	152	0	0	0	Figure 6.12: The authors should eliminate term "Red tide and CO ₂ acidification"- this will lead to confusion suggesting these are underlying mechanisms for hypoxia. (UNITED STATES OF AMERICA)	We have heavily revised this figure for matching the content of the chapter.
927	58254	6	156	0	0	0	in figure B change m by km when indicate the median shift in latitude (Ricardo Anadon, University of Oviedo)	We have revised this figure, and corrected the typos. Thank you
928	72501	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)	We have revised the figure. A box+whisker plot is a common way to present data and we revised figure caption and text to be more precise.
929	81390	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. (Yuka Estrada, IPCC WGII TSU)	We have revised the figure, figure caption and text to be more precise
930	68087	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)	We have removed national borders.
931	82108	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. (Katharine Mach, IPCC WGII TSU)	We have revised the figure, figure caption and text to be make this more clear.
932	58255	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 (Ricardo Anadon, University of Oviedo)	We have revised the figure and improved the positioning of legends.
933	72502	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)	We have revised the figure, figure caption and text to be more precise. We now mention confidence in detection and attribution as one legend and do the same for projection.
934	72503	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)	We agree and think the current way of having acronyms in text and figure links both in the clearest possible way. Other reviewer comments have led us to convert the acronyms into numbers for the actual depiction in the figure. The key is still there and should allow linking to the text.
935	80724	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. (Jean-Pierre Gattuso, Centre National de la Recherche Scientifique)	We have revised the figure and the chapter text in order to assure consistency. Note that these are high level conclusions summarizing the role of individual phenomena.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
936	82109	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. (Katharine Mach, IPCC WGII TSU)	We would like to keep the figure as this is a very clear option to present the chapter conclusions. The risk table should complement the requested information.
937	72504	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)	The comments to boxes have been dealt with separately.
938	72505	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)	The panels are now cited in the text (and in the right order)..
939	72506	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)	The various panels are now mentioned in the text
940	72507	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)	The various panels are now mentioned in the text
941	72508	6	161	0	0	0	Figure OA-1C: Reference to figure X.C should be changed to figure OA-1C. (UNITED STATES OF AMERICA)	The text has been corrected accordingly.