#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
1	35926	6	0	0	0	0	General comment - there are projections which suggest wind fields and currents will change with time, leading to e.g. an expansion of subtropical domains and loss of temperate habitat (e.g. Polovina, J.J., Dunne, J.P., Woodworth, P.A., & Howell, E.A. Projected expansion of the subtropical biome and contraction of the temperate and equatorial upwelling biomes in the North Pacific under global warming. – ICES J. Mar. Sci. 68, 986-995 (2011). This type of large scale impact of warming seems to have been omitted, yet is the basis for much of the discussion on changes to upwelling domains and changes in ocean productivity (add to 6.1.1.4? or new section under 6.1.1?) Ayers and Lozier (2010. JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 115, C05001, doi:10.1029/2009JC005596) suggest most of the nutrient supplied to the N Pacific transition zone in winter is transported by wind. Thus, a northward shift in westerlies will result in a northward shift in the transition zone and an expansion of the subtropical domain, something that may be already occurring according to satellite chlorophyll (Polovina et al 2008. GEOPHYSICAL RESEARCH LETTERS, VOL. 35, L03618, doi:10.1029/2007GL031745). (Frank Whitney, Institute of Ocean Sciences)	We have addressed the highly uncertain issue of NPP changes with sufficient scrutiny but in light of that prefer to not delve into the physical background in more detail as this is a WGI issue.
2	36284	6	0	0	0	0	I have an impression that some of conclusions were made based on the results obtained at the vert limiated geographical locations that might not repserent ecosystem changes of those oceanic regions well (e.g. one of possible reasons of disagreement with satellites and in situ observation results on primary productivity in subtropical gyres). I understand this is because of lack of long-term ecological monitoring data in open ocean though. However, it still seems to lack information/references on subarctic North Pacific despite that there are several long-term biogeochemical, and lower and higher trohphic data/references available in both eastern and western subarctic NP although some of those are refered in Chapter 30. (Sanae Chiba, JAMSTEC)	We cannot cover every region in depth - that's were chapter 30 comes into play. We have focused on the oligotrophic oceanic time series stations as they provide the most robust comparisons with some of the remote-sensing based reports of a lower productivity oligotrophic ocean as viewed from space.
3	37174	6	0	0	0	0	This Chapter presents a reasonable overview of the state of knowledge and prediction concerning the anticipated effects of climate change on ocean systems. The overall balance was a bit uneven, with, perhaps, too much about the North Sea and NE Atlantic, and much less about most of the S and N Pacific, but this reflects the composition of the published work. There is, as well, quite a lot of repetition of the same points in various sections, but this is perhaps inevitable in such a long many-authored Chapter. In addition, it doesn't hurt to make major points more than once. I have tired to inject a slightly broader view, drawing on my knowledge of the NW Atlantic ecosystems, hopefully other reviewers will do the same for other under-represented regions. I have also pointed out things that I think are wrong or misleading as written. I could have "gone-to-town" on the language, but that's not my job - we (reviewers) have been asked rather to comment on the scope and balance of the content and associated literature references. Nevertheless, I have made a few detailed comments on the Executive Summary because this is the section that will be read by the most people, and by people who are not so familiar with the field, so that I thought it was important not to let any ambiguities slip through (Erica Head, Fisheries and Oceans Canada)	These comments are very balanced and overall agreeable. Please note that our focus is on the principles and less on a regional balance. This is taken care of by chapter 30. Redundancies have been eliminated. We have now selected case studies showing the principles, with some regional balance.
4	38515	6	0	0	0	0	I have always appreciated how the IPCC strives to precisely express the quality of evidence, agreement, and confidence in specific outcomes. However, this chapter abuses this approach, and in my mind, this diultes the overall message of the chapter. There are a number of instances where the italized IPCC-quanitifers when I don't think they are necessary. I think these statements should be used judiciously--too many distracts from the really important points. Furthermore, there are many instances where the chapter mentions "high confidence" that something will change, without stating the direction of the change. Statements like this are meaningless and further serve to dilute the impact of the paper. To use an economic analogy, I'm quite certain that the Dow Jones Industrial average will change today, but I have no idea whether it will go up or down. The direction is what matters. Please continue to characterize what we know about the system in question and why you expect that it will be different in the future, but please reserve the italicized quantifiers for statements where there is a clear direction. (Andrew Pershing, University of Maine)	We are well aware of this and have screened the chapter for correct and limited application of uncertainty language.
5	38873	6	0	0	0	0	It is not good practice to use language in the executive summary that cannot be found in the underpinning chapters, e.g. ocean frontal feature. (Klaus Radunsky, Umweltbundesamt)	Your suggestion has been incorporated.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
6	39015	6	0	0	0	0	GENERAL COMMENTS. I congratulate the authors in assembling a massive amount of pertinent information and drawing from these diverse data what seem appropriate conclusions re: the diverse effects of climate change and the confidence with which these conclusions should be accepted. The writing varies a lot in, for lack of a better term, "density." Some sections seem to hit the nail on the head in terms of presenting just the right amount of information and stating conclusions in a concise manner. Other sections contain enormous amounts of information and make the reader's task quite challenging. One common problem concerns redundancy across the sections. Certain topics are bought up at two or more points and I found there to be too much duplication in these presentations. Another problem related to the redundancy issue is that some topics are introduced in a very short, simplistic manner (e.g., local adaptation, lack of information on OA effects on ecosystems) and only later in the document are they given adequate discussion. Some of my comments below reflect this structure. I think the figures will be crucial in getting the chapter's messages across, especially to non-specialist readers who require a view of the 'forest' after being presented with so many different 'trees.' The Frequency Asked Questions found at the end of the text are extremely good. They treat most of the key points in the chapter and provide a reader-friendly overview of topics that are dealt with in (often) complex fashion throughout the chapter. I note that these FAQs are going to be transplanted into the document. I think this is a good plan, for it will help readers work their way though the text more successfully. (George Somero , Stanford University)	In the second order draft, we have minimized overlap between sections and strived for a balanced coverage of the main topics.
7	39287	6	0	0	0	0	GENERAL COMMENTS TO CHAP. 6 The chap. 6 – Oceans is a very long, extensive and detailed analysis of the effects of climate change on oceanic ecosystems. Being a “mechanism-based” scientist, working with individuals and mainly with physiological mechanisms to explain specie-specific responses, I appreciated chap 6 very much. It is the first time, finally, that I read a report not specifically thought for scientists that attempts to start from the scratch of the bio-ecological response, i.e. the response at individual level based on physiological mechanisms. Here, there are some pieces of very sound Science, in which Authors made a huge effort in understanding how all organisms can respond to different climatic drivers, now and in the future. The “acme” of this chap is contained, in my opinion, in the science of fig. 6-7. (Gianluca SARA, University of Palermo)	Thank you for your strong support. We agree on the added value of considering the mechanisms behind ecoogical change and have kept this approach in our revised version.
8	39288	6	0	0	0	0	The mechanistic OCLLT approach is able to describe the shape and width of the performance curve to identify which processes cause shifts in the energy budget, an early decrease in performance and thereby initiate a loss in fitness, with the respective implications at ecosystem level. In agreement with this approach, I particularly appreciated the reasoning dealing with repercussions on the fitness of organisms. (Gianluca SARA, University of Palermo)	These comments are very balanced and agreeable. The appreciation of a mechanistic approach emphasizes its importance in developing an in depth understanding.
9	39289	6	0	0	0	0	To this regard, I could propose to cite Sarà et al. accepted with revisions. The impact of climate change on Mediterranean intertidal communities: losses in coastal ecosystem integrity and services. Regional Environmental Change although still under review for the second round, or also Sarà et al. under review. Predicting biological invasions in marine habitats through eco-physiological mechanistic models: a study case with the bivalve Brachidontes pharaonis. (Gianluca SARA, University of Palermo)	Unfortunately, these papers are not yet published and available to us which is a requirement for inclusion in the chapter but certainly we shall look out for them as examples from various regions should support our reasoning.
10	39290	6	0	0	0	0	These papers could help because of the use of mechanistic niche modeling to study the fitness of marine ectotherms like bivalves in the Mediterranean, both under subtidal and intertidal conditions. I consider the Darwinian fitness (i.e. the amount of eggs produced per life span per unit of biomass) crucial in the response of species to stressors and it is an important aspect to sustain ecosystem resilience under multiple stresses. They could also be cited in section 6.5. (Gianluca SARA, University of Palermo)	see comment 9. These papers are not available to us but certainly we shall look out for them as examples from various regions should support our reasoning.
11	39291	6	0	0	0	0	However, although I appreciated the philosophy of mechanism based knowledge deployed by the Authors as I consider it innovative, smart and pioneering for this type of reports, sometime the information provided in this chapter results redundant and repetitive. I suggest reducing the general amount of information to be more direct. Also, there is a certain difficulty in following the huge amount of headings, sub-headings and sub-sub-headings of many sections (all in italics, I hope that new version will solve this aspect). (Gianluca SARA, University of Palermo)	We have carefully revised for the SOD to identify redundant information between sections, and reduce the subheadings.
12	39292	6	0	0	0	0	The reading is often too complicated by this that I consider, however, correctable FOD issues. An initial diagram to present the structure of how Authors want to present the information could help. I however suggest to simplify and reduce the length of this very large chap. This should not come at the expenses of the mechanism base approach. On the contrary, trying to make it still simpler would strengthen the impact of the impressive amount of information contained in these 200 pages and the power of the mechanism base message. (Gianluca SARA, University of Palermo)	The structure of the chapter is shown in the table of content, whichwel hope the reader will refer to for the overall flow of the chapter. We have reduced the length of chapter text by about half in the second order draft.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
13	39475	6	0	0	0	0	Other relevant publications include: Allen, J.I. (2010) Marine ecosystem response to multiple climatic and anthropogenic drivers: A modelling approach. Comparative Biochemistry and Physiology A-Molecular & Integrative Physiology 157, S1-S1. Badjeck, M.-C., E.H. Allison, A.S. Halls and N.K. Dulvy (2010). Impacts of climate variability and change on fishery-based livelihoods. Marine Policy, Volume 34, Issue 3, 375-383. Barange, M., I. Allen, E. Allison, M.-C. Badjeck, J. Blanchard, B. Drakeford, N.K. Dulvy, J.Harle, R, Holmes, J, Holt, S.Jennings, J. Lowe, G. Merino, C. Mullon, G.Pilling, E. Tompkins, F. Werner 2010. Predicting the impacts and socio-economic consequences of climate change on global marine ecosystems and fisheries: the QUEST_Fish framework. In: Ommer, R. et al., Coping with climate change in marine socio-ecological systems. Blackwell FAR Series, p. 31-59; Barange, M., W. Cheung, G. Merino and R. I. Perry 2010. Modelling the potential impacts of climate change and human activities on the sustainability of marine resources Current Opinion in Environmental Sustainability 2(5-6): 326-333. Barnes, C., D. Maxwell, D.C. Reuman and S. Jennings (2010). Global patterns in predator-prey size relationships reveal size dependency of trophic transfer efficiency. Ecology, 91:222–232. [doi:10.1890/08-2061.1] Drakeford, B. and S. Pascoe (2008). Substitutability of fishmeal and fishoil in diets for salmon and trout: a meta-analysis. Aquaculture Economics and Management, 12: 155-175. Dulvy, N.K, and E.H. Allison. 2009. A place at the table? Nature Reports Climate Change 3: 68-70. Chassot, E., Bonhommeau, S., Dulvy, N.K., Mélin, F., Watson, R., Gascuel, D., Le Pape, O. (2010) Global marine primary production constrains fisheries catches. Ecology Letters, 13 (4), pp. 495-505 and others available on the UK NERC funded international consortium project QUEST-Fish website, http://www.quest-fish.org.uk/publications.html (Sarah Cornell, Stockholm Resilience Centre)	We have revised the suggested bibliography, and incorporated it in the suitable sections.
14	40446	6	0	0	0	0	There are many areas of redundancy - including those that even contradict themselves throughout the chapter. For example, there are many times where changes in NPP are discussed - but they're scattered throughout the document and presented very differently. It makes it hard for the reader to take away a cohesive story. (Laura Petes, National Oceanic and Atmospheric Administration)	The NPP story - from space and from ocean time series has been tied up, brought together and checked for consistency
15	40447	6	0	0	0	0	This chapter should include some examples of adaptation actions underway for marine systems. For example, efforts to set pollock catch limits in the North Pacific based on climate and recruitment data (i.e. adaptive management). (Laura Petes, National Oceanic and Atmospheric Administration)	We have crossreferenced to Chapter 7 section 7.5.1.1.3 that menditons options for fisheries adaptation to climate change (2nd paragraph).
16	40448	6	0	0	0	0	This chapter barely mentions marine commerce and transportation. This is a critical sector that is vulnerable to climate-related changes and merits more discussion in the human systems section. (Laura Petes, National Oceanic and Atmospheric Administration)	We have included a short mention on shipping-related issues, and a cross reference to 30.6.3.3.Shipping.
17	41732	6	0	0	0	0	This chapter is extremely focused on the biological processes affected by climate change. In 6.1.1 and 6.1.2 chemical and physical aspects are briefly mentioned, but maybe they should be discussed in more detail in a chapter "ocean systems". (Juergen Weichselgartner, University of Kiel)	Chemical and physical aspects are the focus of WG I and are only summarized, refering to WGI information.
18	43046	6	0	0	0	0	General comment - the authors have done an excellent job of distilling the main points from disparate sources on a highly complex, and relatively new, area of research (Cliff Law, NIWA)	Thank you for your strong support.
19	44190	6	0	0	0	0	Both titles of section 6.3 and 6.5 have 'projections', which might be easily confusing for readers, although the former talks briefly some extrapolations and the latter discusses some modeling resutls. Actually, both of them have some differences. We use NPP as an example in section 6.3 and 6.5. The former talks mainly about the relationship between NPP and higher nature climate variability, e.g., interannual variability of ENSO cycle, but the latter introduces the modeling results under some scenarios (anthropogenic climate change). However, I am wondering if there are some relationship between section 6.3 and 6.5. Could section 6.5 give us some results about the changes of inter-annual variability of ENSO cycle, even for some longer variabilities, e.g., PDO, AMO, etc. under the senarios and their impacts on the NPP? Obviously no, it is too diffcult to do that, as we know. (RONGSHUO CAI, Third Institute of Oceanography)	We have changed the title of 6.3 to "Trends in biological field observations". In the text we emphasize that mechanistic understanding provides the foundation for projecting climate change effects on ocean systems (6.5).
20	44491	6	0	0	0	0	Executive Summary: Bullet 1 on “Key interrelated factors changing…” in the second part also covers the assessment of the physical causes (“Alteration of oceanographic conditions will be driven by shifts in water mass boundaries and ocean frontal features, along with altered thermohaline stratification (nutrient supply) and mixed layer depth (light regime), ocean warming, acidification and hypoxia (high confidence)”). Is this a key assessment result from this chapter? In any case, it will be critically important to base this assessment primarily on what is provided in WGI AR5 Ch3/6/12 without reassessing the physical science basis if an assessment is included in the WGI contribution. If WGI does not provide what this chapter needs (e.g., for changes in coastal upwelling) then we encourage the authors here to ask the relevant WGI authors for feedback on the assessment provided in this Chapter. (Thomas Stocker, IPCC WGI TSU)	We revised the Executive Summary. We now mention the drivers causing effect with adequate citation of wg1 ch3 & 6, but do not repeat any WGI assessment. Coastal upwelling is not major concern in WG1 but relevant in the context of discussing oxygen minimu zones OMZ and ocean acidification OA.
21	44492	6	0	0	0	0	Executive Summary: Bullet 2: this bullet includes a statement on “unprecedented rates of climate change” and (not very explicitly) attributes them to the CO2 changes (with the bracketed CO2 statement). (1) It seems to us that this assessment is clearly for WGI to be provided and whatever is used here should be based on the WGI AR5 contribution (see Chapter 5 of WGI AR5). There is no need to reassess unprecedented rates of climate change here in the WGII report and consistency should be ensured with the WGI AR5. (2) the same applies to the attribution of the changes in the rates of climate change to CO2 levels. It’s unclear why this would be part of the Executive Summary of this Chapter as it will need to be based on what WGI AR5 will provide. (3) by adding the bracketed CO2 statement, we feel that it becomes unclear what the uncertainty assessment (“robust evidence, high agreement, high confidence”) is referring to – to the “unprecedented rates of change” or to the “linked to ~10 times faster atmospheric CO2 accumulation” statement? (Thomas Stocker, IPCC WGI TSU)	Acidification is not addressed in the paleo chapter 5 in WGI at all and hence cannot be refered to here. The focus of the paleochapter in WGI is the younger part of Earth history and hence the unprecedented rates cannot be assessed in their record. The rate is important as it puts the biotic reaction into a framework and as this is underrepresented in the WGI assessment we need to bring this up here. WGI ch5 SOD never touches the biological impact of historical CO2 change on marine calcifiers, it just cites cenozoic boron isotopic change.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
22	44493	6	0	0	0	0	Executive Summary Bullets on OMZ, Ocean Acidification and Coastal Ocean Upwelling (as well as the relevant sections and subsections, e.g., 6.2.2, 6.3, there specifically 6.3.6.2, and the Conclusions and Key Uncertainties Sections 6.6.1 Drivers of Change and their Effects and 6.6.4 etc.): we encourage you to invite feedback from the relevant authors of the WGI AR5 Chapters 3, 6 and 12 to ensure consistency of the physical science and biogeochemistry aspects of all these topics between WGs I and II. We will be more than happy to assist establishing the contact (if not already established). Relevant WGI Sections in the FOD were, e.g., 3.8.2 and 6.4.4 for Ocean Acidification and 3.8.3 and 6.4.5 for Oxygen. (Thomas Stocker, IPCC WGI TSU)	It would be great to have the feedback and quality control from the relevant authors of the WGI sections to ensure accuracy and the most recent results. We encourage WGI authors to review our SOD in due course.
23	44494	6	0	0	0	0	Section 6.1 could refer to the Ocean Observations Chapter 3 in WGI AR5 early on to link to the assessment of ocean physical science basis observations? E.g., on p8, lines 12-17 or p8, lines 50ff. (Thomas Stocker, IPCC WGI TSU)	Adequate citation of WGI CH3 & 6 has been ensured in our SOD
24	44495	6	0	0	0	0	Section 6.1.1 Recent Trends and Projections of Physical and Chemical Parameters: there is much on WGI-type material, but overall well referenced to mostly Ch3 of WGI AR5 for the observations part. No reference to WGI is provided for the attribution part – suggest to add references to Ch10 of WGI AR5 at the appropriate places, of course including ensuring consistency. (Thomas Stocker, IPCC WGI TSU)	We think it is important to provide some background from WGI as not everybody will read the entire WGI report. Indeed the referencing was stronger in the detection than in the attribution part and this has been rectified.
25	44496	6	0	0	0	0	Section 6.1.1.2 on Ocean Acidification: add references to WGI AR5 Ch6 (or Ch12?) when introducing RCP projections (e.g., p10, l9-17) (Thomas Stocker, IPCC WGI TSU)	We added further references to WG1 CH3 & 6.
26	44497	6	0	0	0	0	Section 6.1.1.3, p12, l27: statement "... is likely to" – please check consistency with WGI Chapter 6 projections of carbon and other biogeochemical cycles. (Thomas Stocker, IPCC WGI TSU)	We checked and added further references to WG1 CH 6.
27	44498	6	0	0	0	0	Section 6.1.1.4, p13: suggest to put this assessment of changes in coastal ocean upwelling under climate change into context with the assessment of larger-scale ocean changes by referring to the relevant WGI Chapters (here Ch3 and Ch12). Same applies to the discussion of climate change-induced stratification (see Ch12 or perhaps even the assessment in Ch3 WGI TAR) rather than citing a single study, which dates back more than the IPCC TAR, to support the statement (Sarmiento et al 1998)). (Thomas Stocker, IPCC WGI TSU)	This is now cross referenced to chapter 12, coastal upwelling is just consisely written in ch3.
28	44499	6	0	0	0	0	Section 6.1.1.5: the construction of the sentence on lines 36-38 with the "with high confidence" added at the end makes it impossible to determine what this "high confidence" applies to. Does it apply to the "Ice melt or an excess of precipitation over evaporation due to climate change cause salinity reductions" or to the "thereby, support enhanced stratification" or to the "as well as an exacerbation of ocean acidification"? (Thomas Stocker, IPCC WGI TSU)	We rewrote the sentence to clarify.
29	44500	6	0	0	0	0	Section 6.1.2: add reference to Ch5 and Ch6 (in particular section 6.2) of WGI AR5 when discussing the paleo-CO2 record. Ensure consistency in assessments. For example, Figure 6.4 here includes parts which are assessed in WGI AR5 and which should be referred to in the Figure (caption). And avoid reassessing the physical science basis in this chapter, e.g., on rates of CO2 emissions: rather than coming up with your own concluding assessment statement "In conclusion, we can deduce with high confidence from the geological record that the current rate of (mainly fossil fuel) CO2 release and the associated rate and magnitude of modern ocean acidification are unparalleled in at least the last ~300 Myr of Earth history. This highlights the magnitude and scale of the current environmental change.", we strongly suggest to refer to the WGI AR5 contribution here, in particular Chapter 5. (Thomas Stocker, IPCC WGI TSU)	WGI has unfortunatly a very shallow time approach to climate change and hence does not discuss 300 Ma long term background variation. While more reference can be added the topic overall is not discussed in WGI. The word acidification is not mentioned once in the entire chapter 5 and hence cannot be referenced. There is no comparable CO2 record figure in Chs 5 and 6 of WGI. The figures for the Industrial period are using the same data as in WGI and are referencing their chapers (Ocean observation and paleo).
30	44501	6	0	0	0	0	Section 6.1.3. Recent Trends in Long-Term Biological Observations: refer to Ch3 of WGI AR5 when discussing general sampling issues in ocean observations (mostly sections 6.1.3.1 and intro to 6.1.3.2) (Thomas Stocker, IPCC WGI TSU)	We have added the suggested citations in our chapter assessment.
31	44502	6	0	0	0	0	Section 6.4.1.2.1: refer to WGI AR5 Ch5 for latest assessment of paleo CO2 record and to Ch6 for global carbon and other biogeochemical cycles and their feedbacks with the physical climate system. (Thomas Stocker, IPCC WGI TSU)	reference now added as appropriate
32	44503	6	0	0	0	0	Section 6.4.2.2 on Geoengineering: 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. (Thomas Stocker, IPCC WGI TSU)	section has been balanced with WGI, ch. 7
33	44504	6	0	0	0	0	Section 6.4.2.4: refer to, e.g., WGI AR5 Ch6 for climate-CO2 feedbacks and to Ch14 for regional climate changes associated with non-climate drivers such as O3. You migh also want to check Annex II of WGI AR5 for Climate System Scenario Tables. (Thomas Stocker, IPCC WGI TSU)	section has been balanced with WGI, ch. 6 and 14
34	44505	6	0	0	0	0	Sections 6.6.1 and 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. (Thomas Stocker, IPCC WGI TSU)	WGI chapters 3 and 6 were checked for relevant updates and cross referenced
35	44506	6	0	0	0	0	FAQ6.2: this FAQ "What does the geological past teach us about future oceans and ecosystem responses to climate change?" to a large extent deals with WGI type of issues, i.e., rate of climate change past and present and attribution of these changes in the rates to rate of CO2 changes. We thus have serious concern with the current focus of this FAQ. In particular the response currently given is purely physical and does not deal with impacts. We suggest this FAQ to focus on the consequences of this for exposure, vulnerability, impacts, etc.With the current focus of this FAQ, there is a serious risk here of cross-working group inconsistency and overlap that is best avoided. In addition, the FAQ makes some quantitative statements on biorestoration, but without communicating uncertainties. (Thomas Stocker, IPCC WGI TSU)	We reworded this FAQ. Now focussing on the biotic reaction to fast rates and its effects on adapation potential and generation time.
36	45604	6	0	0	0	0	Chapter 30 complements Chapter 6 well in that Chapter 30 gives a detailed analysis of detection and attribution of climate change impacts on marine organisms and ecosystems, while Chapter 6 focuses more on underlying mechanisms and projections of future impacts on the biota. Conversely, Chapter 30 presents detailed information on projected temperature changes according to RCP scenarios, which is currently lacking in Chapter 6. (Astrid Wittmann, Alfred Wegener Institute for Polar and Marine Research)	No action needed.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
37	45605	6	0	0	0	0	Inconsistency between Chapter 30 and Chapter 6: Whereas the authors of Chapter 30 state that "Longhurst, 1998 identified over 75 distinct ecological provinces..." (p. 5, l. 17), the authors of Chapter 6 state that the 4 biomes were subdivided "into a total of 51 provinces" (p. 8, l. 25 and Figure 6-1). (Astrid Wittmann, Alfred Wegener Institute for Polar and Marine Research)	We have kept our figure as an illustration of ocean variability as it is well based on the literature.
38	45606	6	0	0	0	0	Figure 6-1 in Chapter 6 (p. 8) is almost identical to Figure 30-1 in Chapter 30 (p. 5). (Astrid Wittmann, Alfred Wegener Institute for Polar and Marine Research)	We have kept our figure as an illustration of ocean variability as it is well based on the literature.
39	45608	6	0	0	0	0	Chapter 30 and Chapter 6 overlap considerably with respect to changes in phenology, abundance and distribution of plankton in the North Atlantic, impacts and projections on fisheries, eastern boundy upwelling systems and coral reefs. (Astrid Wittmann, Alfred Wegener Institute for Polar and Marine Research)	In the SOD, Chapter 6 focuses on assessing the overall responses, impacts and vulnerabilities in the ocean for these topics, while we suggest the regional-/specific ocean-basic focused assessment to be made in Ch. 30.
40	46478	6	0	0	0	0	I am only part the way through this Chapter but I already see huge overlap with Chapter 30, much more than I expected from reading Chapter 30. Chapter 6 is generally more conservative in the conclusions it draws from the literature and has a much tighter evidence base underlying all major conclusions. Chapter 6 does tread into regional literature eg on coastal upwelling and enclosed seas, though its objectives are very much built around asessing knowledge of global processes and claimed change acting at the global level. (Neville Smith, Bureau of Meteorology)	Indeed regional coastal upwelling and enclosed seas are regional issues and should just briefly be touched on here for their processes but otherwise be handled by chapter 30. We have further balanced these issues.
41	46479	6	0	0	0	0	These Chapter is extremely well written, comprehensive to a fault, and has no gaps or weaknesses that I could identify (though much of the material is beyond my immediate expertise). The systematic approach to each topic, analysing the evidence, testing agreement, then drawing together the main points in the form of a summary conclusion gave me great confidence in the outcome. The major issue is the length. There are many review-like sections (and background) which are probably a luxury that cannot be afforded (though they certainly helped me better understand the assessment). There are many efficiencies to be gained with Chp 30 but it is still hard to see this being brought back to ~ 20 pages without losing much valuable material. (Neville Smith, Bureau of Meteorology)	Thank you for your strong support which we hope will translate to the SOD. We condensed the text by about 50% and moved detail into tables.
42	46766	6	0	0	0	0	All three chapters mention ocean acidification and coral reefs in varying details. It will be good to compare the relevant subsections (as for example, 5.3.1.6, 5.4.1.6.) with those of Chapter 6 and 30. (Venugopalan Ittekkot, University of Bremen (retired))	We have agreed on a crosschapter box on coral reefs and specific issues to be covered in each chapter.
43	46768	6	0	0	0	0	This chapter is a detailed and comprehensive overview of what is currently available in the scientific literature on the ecology and biogeochemistry of oceans, and their response to projected climate and other global changes. Although Chapter 30 covers ocean physical processes in detail, it might be useful to touch briefly upon them in Chapter 6 too. Otherwise a more appropriate title will be Ocean Ecosystems rather than Ocean Systems! It has several parts that deal with ongoing programs or are intended as "primers" on physiological and biogeochemical processes which probably need not be in the main text body (boxes?). (Venugopalan Ittekkot, University of Bremen (retired))	This recommendation is not in full agreement with the structure of AR5. WGII sectoral chapters build on WGI treatments, the regional ones cover WGi to III issues (Physical change related circulation change are well covered in WG1 CH3 and WG2 CH30)
44	46884	6	0	0	0	0	At the moment, the captions for tables and figures include a discussion/explanation of the table or figure. It would be clearer if the captions were a brief description and then the discussion was included within the text to illustrate the points being made. (Genevra Harker, HarmonicQuay Ltd)	This is a valid point. We have improved the balance between text and figure legends.
45	46885	6	0	0	0	0	Keep in the third person - avoid using 'we'. (Genevra Harker, HarmonicQuay Ltd)	We agree and have adopted this view.
46	46888	6	0	0	0	0	Be careful with the use of 'fishes' rather than 'fish'. Fishes should only be used when referring to multiple species and not just multiple fish. (Genevra Harker, HarmonicQuay Ltd)	Noted. The term "fishes" has been used appropriately in the SOD.
47	46893	6	0	0	0	0	There is no discussion on the physical aspects of the ocean in relation to circulation. Upwelling is briefly mentioned, but the larger scale changes are not discussed at all. It would be helpful to have a section on the underlying physical changes that are expected/have been observed. (Genevra Harker, HarmonicQuay Ltd)	These physical changes are well covered in the WGI assessment. Biological consequences of large scale physical changes have now been addressed, in 6.1., with reference to WGI, ch. 3, 6 for the physical background
48	47270	6	0	0	0	0	Overall I think the influence of solubility (ventilation temperature) on subsurface oxygen is given too little emphasis. It is not mentioned in the paragraph at the top of p. 5 or on 12/4-41, for example. It may prove to be less important than other factors, but right now it is the only thing we can state with confidence is changing more or less monotonically. The effects of circulation and remineralization may be dominant regionally but there is no a priori reason for these to produce a uniform global trend. On 82/17-18 it states that "expanding OMZs are therefore a consequence of high nutrient loading or restricted water movement, or both." But we have no real evidence that either of these things has changed over historical time. What we do know for certain has changed is the ventilation temperature. (James Christian, Government of Canada)	This point is well taken. Certainly water ventilated at warmer temperature will have less oxygen once cooling off but will not reach the very low oxygenation levels observed. Nutrient loading and microbial respiration are key in generating OMZs. The influence of warming on gas solubility and biological rates has now been emphasized.
49	47271	6	0	0	0	0	When impacts of ocean acidification are discussed it somehow needs to be made clear that OA is not a consequence of climate change but an independent and parallel consequence of CO2 accumulation. At present OA impacts are often treated as AGW impacts (e.g., 7/17). (James Christian, Government of Canada)	With the present drivers OA is tighly coupled to other processes characterizing climate change. This coupling needs to be acknowledged so OA can be understood as one of the drivers changing with climate change..
50	47272	6	0	0	0	0	The hypothesis that changes in land-sea temperature gradients will affect upwelling-favourable winds in consistent and predictable ways in coastal upwelling systems remains a hypothesis. This is stated in what I would call a cautious and responsible manner e.g., on p 7 lines13-15 and p. 13 lines 5-18, but elsewhere it is implied to be a robust inference (e.g., p. 62 lines 43-54). (James Christian, Government of Canada)	This has been tidied up for consistency.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
51	47273	6	0	0	0	0	The text frequently refers to “climate change” when it means anthropogenic climate change; this definition needs to be stated up front or the word anthropogenic should be inserted in every case. On p. 79, changes in phytoplankton community structure are asserted to result "from greenhouse gas emission". Well, yes, indirectly, via anthropogenic climate change, but the terminology should be consistent. (James Christian, Government of Canada)	Whether Climate Change is caused by human activities is defined and dealt with in detail in WGI. For assessing biological sensitivity and effect such differentiation between natural variability and anthropogenic change has not been made in every single observation but the anthropogenic aspect is obvious for projections. We now emphasize the changes in climate and ocean conditions that lead to changes in NPP. We also state where changes in NPP result from changes in climate and ocean conditions following IPCC scenarios.
52	50300	6	0	0	0	0	1) Overall -- In preparing the 2nd-order draft, the chapter team should prioritize making each section of the chapter a polished, comprehensive treatment of topics considered. From these sections, the chapter team is then encouraged to maximize the utility of its findings, ensuring that they are robust, compelling, and nuanced. Themes to consider informing in constructing findings include decisionmaking under uncertainty, risks of extreme events and disasters, avoided damages, and limits to adaptation. To these ends, the chapter team has prepared a superb 1st-order draft. In an effort to inform further chapter development, I provide a few general and specific comments below. (Katharine Mach, IPCC WGII TSU)	We appreciate these general comments and the clear decription of our accomplishments and we have strived to fulfill those goals in the SOD.
53	50301	6	0	0	0	0	2) Highlighting key findings -- The author team has very effectively highlighted key findings across chapter sections, using calibrated uncertainty language to characterize its degree of certainty in these conclusions. As a result, a reader of the chapter can readily understand how the literature reviews and syntheses in chapter sections--the traceable accounts--support the conclusions of the chapter, also as featured in the executive summary. (Katharine Mach, IPCC WGII TSU)	Thank you for your strong support.
54	50302	6	0	0	0	0	3) Usage conventions for calibrated uncertainty language -- As done nearly everywhere in the chapter, calibrated uncertainty language should be italicized where used. For the 2nd-order draft, the author team may wish to consider further parenthetical presentation of calibrated terms--at the end of clauses or sentences--to maximize the directness of wording in the conclusions. Finally, the author team should continue to avoid casual usage of reserved uncertainty terms. (Katharine Mach, IPCC WGII TSU)	The text has been revised to incorporate this perspective. Calibrated uncertainty language was revised through the text.
55	50303	6	0	0	0	0	4) Summary terms for evidence and agreement -- The chapter team is encouraged to revisit statements for which a summary term is provided for evidence, but not for agreement. In such cases, the author team should consider characterizing agreement as well, with parenthetical presentation of summary terms for evidence and agreement as an option to save space and maintain concise phrasing. Additionally, there may be statements for which the author team could present only a level of confidence, without summary terms for evidence and/or agreement. The TSU would be happy to discuss evidence and agreement further with the author team, if exploring the framework for treatment of uncertainties in this regard would be of use. (Katharine Mach, IPCC WGII TSU)	The text has been revised to incorporate this perspective. Calibrated uncertainty language was revised through the text.
56	50304	6	0	0	0	0	5) Further reduction of redundancy across chapter sections -- The chapter team has adopted an effective and clear approach to dividing its assessment across sections 6.2-6.5. In preparing the 2nd-order draft, the author team might find further opportunities for tightening its assessment through additional reduction of overlap across subsections of 6.2-6.5. (Katharine Mach, IPCC WGII TSU)	Agreed, the structure of the chapter has been reconsidered in order to minimize redundancy.
57	50305	6	0	0	0	0	6) Specificity of described observations and projections -- The author team is very much encouraged to continue presenting observed and projected impacts with the high level of specificity already employed. In addition, as can be supported by the literature, the author team should continue to seek opportunities for providing specific information on differences in outcomes projected across future climate/socio-economic scenarios. (Katharine Mach, IPCC WGII TSU)	The text has been revised to incorporate this perspective and provide more specific outcomes of observations and projections.
58	50306	6	0	0	0	0	7) Conditional constructions -- The chapter team has also effectively used constructions that explicitly separate given physical changes from corresponding conditional impacts. The chapter team is encouraged to continue using such constructions, also separately characterizing the degree of certainty for a physical change and a conditional outcome where appropriate. (Katharine Mach, IPCC WGII TSU)	We now refer to the assessment results by WGI more consistently. We have phrased conditional outcomes where appropriate. We have added a sentence in 6.5 to point out that uncertainty of future projections is contingent on the level of confidence in projected climate and oceanographic changes (WGI and 6.1.1).
59	50307	6	0	0	0	0	8) Figures -- The author team is applauded in developing a rich and informative series of figures to complement assessment in the chapter text. I will look forward to seeing the further evolution of these figures as the chapter's assessment progresses. (Katharine Mach, IPCC WGII TSU)	Thank you for your strong support. We have developed these figures further.
60	50308	6	0	0	0	0	9) Coordination across the Working Group 2 contribution -- In developing the next draft of the chapter, the author team should consider treatment of topics not only in this chapter, but also across the report as a whole. For each topic, the chapter team should ensure that treatment here is reduced to the essence of what is relevant to the chapter, with cross-references made to other chapters as appropriate, also minimizing overlap in this way. In particular, the author team should continue to coordinate with chapter 30 (as well as chapters 5, 28, etc.) to ensure harmonized assessment, with logical handoffs between sectoral and regional treatments, with consistency in findings presented, and with overlap reduced wherever possible. (Katharine Mach, IPCC WGII TSU)	Several crossreferences were included, the assessment has been harmonized.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
61	50309	6	0	0	0	0	10) Harmonization with the Working Group 1 contribution to the AR5 -- At this stage of chapter drafting, the author team should carefully consider the working group 1 contribution. Wherever climate, climate change, climate variability, and extreme events are discussed, the chapter team should ensure that their treatment is harmonized with the assessment findings of working group 1. (Katharine Mach, IPCC WGII TSU)	We have harmonized our assessment with that of WG I in the SOD.
62	52510	6	0	0	0	0	This is a comprehensive chapter covers the oceans well. The sections on ecosystem services work well as do the Frequently Asked Questions section. There is obviously some overlap with Chapter 5. (Coastal Systems) and this needs to be handled with care. Often insights from experimentally tractable coastal systems inform work of more open oceanic systems. Repetition is probably better than strict segregation as many people will not read both chapters. However, what is included or not will be a challenge for the editor. There are two generic comments in this chapter. (1) The level of referencing does not seem as detailed as the last IPCC - is this deliberate policy? I think that a comprehensive approach to evidence should be used wherever possible. Also in one or two places a few very recent papers are cited to justify a long known fact (i.e. temperature shapes biogeography). This has been known for a long-time from classic studies (Ekman, Orton, Thorson, Hutchins, Luning and many others). The high confidence that we have in the influence of temperature on distribution stems from this work. (2) There is some very "teleological" writing in places. A species does not extend its range - the range of individuals of a species becomes extended as they respond to environmental drivers. Similarly species do not (decide to) extend their breeding season. Individuals are reproductively active earlier and for longer. Sorry to be pedantic but this is poor and I get cross with myself when I find myself using this mental short-hand. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We have thought carefully about the following statement "Often insights from experimentally tractable coastal systems inform work of more open oceanic systems. " We have already been through this issue in our discussion of the wider offshore relevance of coastal mesocosms. The point about classical studies on temperature shaping biogeography has been included.
63	52582	6	0	0	0	0	References to be added: Southward et al., 2005. Long-term oceanographic and ecological research in the western English Channel, Advances in Marine Biology, 47: 1-105 Southward, 1980. The Western English Channel - an inconstant ecosystem? Nature, 285: 361-366. Hawkins S.J., Southward A.J., Genner M.J. 2003. Detection of environmental change in a marine ecosystem - evidence from the western English Channel. Sci. Total Environ. 310: 245-246. Helmuth B., Mieszkowska, N., Moore, P., Hawkins S.J. 2006. Living on the edge of two changing worlds: forecasting the responses of rocky intertidal ecosystems to climate change. Annu. Rev. Ecol. Evol. Syst. 37: 373-404. Polocanska, E.S., Hawkins S.J., Southward A.J., Burrows M.T. 2008. Modelling the response of populations of competing species to climate change. Ecology, 89: 3138-3149. Simpson, S.D., Jennings, S., Johnson, M.P., Blanchard, J.L., Schon, P.-J., Sims, D.W. and Genner, M.J. 2011. Continental shelf-wide response of a fish assemblage to rapid warming of the sea. Current Biology 21: 1565-1570. Genner, M.J., Sims, D.W., Wearmouth, V.J., Southall, E.J., Southward, A.J., Henderson, P.A., Hawkins, S.J. 2004. Regional climatic warming drives long term community changes of British marine fish. Proc. P. Soc. Lond. B. 271: 655-661. Perry, A.L., Low, P.J., Ellis, J.R., Reynolds, J.D. 2005. Climate change and distribution shifts in marine fishes, Science 308: 1912-1915. Hawkins, S.J. (2012) Marine conservation in a rapidly changing world. Aquatic Conservation Marine and Freshwater Ecosystems, 22, 281-287. Hawkins, S.J., Sugden, H.E., Mieszkowska, N., Moore, P.J., Poloczanska, E., Leaper, R., Herbert, R.J.H., Genner, M.J., Moschella, P.S., Thompson, R.C., Jenkins, S.R., Southward, A.J. and 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. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We appreciate this input but have to point out that a detailed treatment of the intertidal and even coastal aspects may not be appopriate for our chapter which has a focus on the open oceans. We feel that coastal details should be left to chapter 5. Chapter 6 has a focus on generic principles and relevant case studies, regional studies will be dealt with by chapter 30.
64	52583	6	0	0	0	0	References to be added: Hawkins, S.J., Moore, P.J., Burrows, M.T., Poloczanska, E., Mieszkowska, N., Herbert, R.J.H., Jenkins, S.R., Thompson, R.C., Genner, M.J. and 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., Moore, P.J., Burrows, M.T., Poloczanska, E., Mieszkowska, N., Herbert, R.J.H., Jenkins, S.R., Thompson, R.C., Genner, M.J. and 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. Herbert, R.J.H., Hawkins, S.J., Sheader, M. and Southward, A.J. (2003) Range extension and reproduction of the barnacle Balanus perforatus in the eastern English Channel. Journal of the Marine Biological Association of the United Kingdom, 83, (1), 73-82. Hiscock, Keith, Southward, Alan, Tittley, Ian and Hawkins, Stephen (2004) Effects of changing temperature on benthic marine life in Britain and Ireland. Aquatic Conservation Marine and Freshwater Ecosystems, 14, (4), 333-362. Mieszkowska, N.., Leaper, R., Moore, P., Kendall, M.A., Burrows, M.T., Lear, D., Poloczanska, E., Hiscock, K., Moschella, P.S., Thompson, R.C., Herbert, R.J., Laffoley, D., Baxter, J., Southward, A.J. and Hawkins, S.J. 2005. Marine Biodiversity and Climate Change: Assessing and Predicting the Influence of Climatic Change Using Intertidal Rocky Shore Biota. Occasional Publications. Marine Biological Association of the United Kingdom 20: 53p. Whitman, J., Cusson, M., Archambault, P., Pershing, A. & Mieszkowska, N.., 2008. The relation between productivity and species diversity in temperate-arctic marine systems. Ecology 89, Supplement 06: 66-80. Genner, Martin J., Sims, David W., Southward, Alan J., Budd, Georgina C., Masterson, Patricia, McHugh, Matthew, Rendle, Peter, Southall, Emily J., Wearmouth, Victoria J. and Hawkins, Stephen J. (2010) Body size-dependent responses of a marine fish assemblage to climate change and fishing over a century-long scale. Global Change Biology, 16, (2), 517-527. Hawkins, S.J., Hartnoll, R. G. 1985. Factors determining the upper limits of intertidal canopy-forming algae. Marine ecology progress series. 20: 265-271. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Clearly, some of these references should be added but not all, considering our focus on the oceans. We have forwarded those to the chapter 5 team.
65	52642	6	0	0	0	0	Generally very well written chapter! Biological focus, thorough, clearly structured, rich in biological information and explanation of processes, important effects and consequences in depth discussed and evaluated. A model chapter for this report! (Else Marie Løbersli, Norwegian directorate for nature management)	Thank you for your strong support.
66	52643	6	0	0	0	0	Summary is very good and detailed (Else Marie Løbersli, Norwegian directorate for nature management)	Thank you for your strong support.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
67	54408	6	0	0	0	0	GENERAL COMMENTS: I would like to thank the authors for a very interesting and enjoyable FOD. When considering the expert review comments received on your chapter and the next round of revisions, I suggest several overall priorities. (1) Keep in mind that the preparation of the SOD is the time to ensure that each section of the chapter presents a comprehensive treatment of relevant literature, and that the Executive Summary presents findings that capture the key insights that arise from the chapter assessment. (2) This is also the time to focus on distilling the chapter text, not just fine-tuning wording but editing with a critical eye to improving quality by making discussions succinct and synthetic, while still being comprehensive. (3) Cross-chapter coordination is also important at this stage, as it should now be possible to identify topics that overlap with other chapters and to coordinate with other chapter teams to minimize that overlap. (4) Cross-Working Group coordination is important as well, and relevant chapter sections should cross-reference chapters from the other Working Groups, particularly in the case of statements about changes in mean or extreme climate conditions that are assessed in the contribution of Working Group I. (Michael Mastrandrea, IPCC WGII TSU)	We appreciate these general comments and the clear decription of our goals and accomplishments. We have revised accordingly for SOD.
68	54409	6	0	0	0	0	EXECUTIVE SUMMARY: The author team has made an excellent draft of the Executive Summary, including clear attention to providing traceable accounts (see separate comment on this) and calibrated uncertainty language. The findings provide an impressive amount of detail in summarizing the chapter assessment, although the result is a long Executive Summary. For the SOD, I recommend the author team consider ways to focus the Executive Summary. This could involve removing or merging some findings, or changing the balance of what details are communicated in the chapter text vs. the Executive Summary findings. Also, the first few and the last few findings seem more targeted to a general audience, while many of those in the middle seem more targeted to the research community. It is worth considering a reordering of the findings such that those that may be of more interest to a general audience come first, followed by those that delve into greater detail about specific topics. In addition, for the SOD I recommend considering the usage of evidence and confidence assignments where an assignment of agreement is not made (or vice versa). Assignments of evidence are generally paired with a level of agreement, which together may form the basis for a level of confidence. I suggest either moving to presentation of levels of confidence on their own (with the description of underlying evidence and agreement appearing in the corresponding chapter text), or presenting agreement/evidence assignments as a basis for confidence wherever possible (e.g., high confidence based on high agreement, medium evidence), as is done in many cases already. We in the TSU are also available to discuss these issues if that would be of use. (Michael Mastrandrea, IPCC WGII TSU)	Executive summary has been shortened and reordered. The specific use of calibrated language has been improved.
69	54410	6	0	0	0	0	TRACEABLE ACCOUNTS: The author team has made an excellent start to providing traceable accounts for assessment findings and highlighting the location of those traceable accounts in the Executive Summary. In general, the Executive Summary findings are well supported. In the SOD, I would recommend the author team continue to strengthen the linkages between the Executive Summary findings and the corresponding chapter text. Calibrated uncertainty language is used extensively and effectively in the chapter, which provides the opportunity to nitpick because you have done such a good job. In many cases this is done well, but in some cases, the linkage to the language used in the Executive Summary is not as clear as it could be in the chapter text. This is sometimes when the Executive Summary language is synthesizing across more specific assignments in the chapter text, for which there may be opportunities to strengthen the linkages particularly in the conclusions sections that appear in the chapter. In a few cases, similar statements in the Executive Summary and the chapter text do not seem to match in terms of calibrated language, so please check this during revisions. Finally, the standard convention is for line of sight to chapter sections to appear after each Executive Summary paragraph as a whole. You may wish to additionally include reference to specific chapter sections after individual non-bold sentences (e.g., if the finding is synthesizing information in several chapter sections but certain points are from specific sections). But the general approach would avoid confusion in interpreting the line of sight for the bold finding. Please also be as specific as possible in citing chapter sections in the Executive Summary where traceable accounts can be found. (Michael Mastrandrea, IPCC WGII TSU)	The links between executive summary and chapter text have been strengthened, with respect to use of calibrated language and citing chapter sections. Summarizing statements were balanced with the conclusion sections in the text.
70	54908	6	0	0	0	0	The author team should update the reference list and remove citation inconsistencies between in text citations and full citations given in the reference list. Please see supplementary document named WG2AR5-Chap6_Reference Checks.pdf at https://ipcc-wg2.gov/AR5/author/FOD/SuppMat (Monalisa Chatterjee, IPCC WGII TSU)	agreed and implemented
71	39008	6	1	1	0	0	It would have been interesting to read and review the oceans chapter, but the sheer volume of this renders the task impossible. This is unfortunate since there is certainly a real need for analysing and linking the body of existing knowledge with the needs of policy makers to understand the existing impacts of recent climate change, as well as their possible future evolution. (Wolfgang Cramer, Potsdam Institute for Climate Impact Research)	We appreciate the overly tight time budget of this reviewer and would like to encourage him to study our SOD.
72	37175	6	2	30	0	0	The first mention of “microbes” should include (in brackets) a list of what we are talking about e.g. (bacteria, phytoplankton, archaea) (Erica Head, Fisheries and Oceans Canada)	The text has been revised accordingly
73	37176	6	2	48	0	0	lified” be replaced by “quantified”? (Erica Head, Fisheries and Oceans Canada)	This section has been revised and sentence lost.
74	52520	6	2	49	0	0	(should read) ….and the degree or capacity for…. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Comment not intended for Chapter 6
75	35927	6	3	0	7	0	overall a strong Executive Summary. One concern I have is that Marine Protected Areas must be selected with an understanding of the potential losses of habitat in the future. Mid-water habitat in the subarctic Pacific will likely continue to lose oxygen as upper ocean stratification increases. Therefore mid-water MPAs may be ineffectual if they don't allow for species migration where possible. I don't know if this is worth including under any discussion of ocean management strategies? (Frank Whitney, Institute of Ocean Sciences)	The executive summary now includes consequences for conservation. This is dealt with in 6.4. in a more generic way. Management decisions have to take potential implications of climate change on habitat into account.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
76	39461	6	3	0	7	0	General comments on chapter 6: Very complicated executive summary - needs to be more concise, with a clearer synthesis structure. Perhaps be clearer about the physical drivers/controls on ecosystem changes, biogeochemical changes and organism effects. New insights need to be drawn out more clearly. (Sarah Cornell, Stockholm Resilience Centre)	agreed, the Executive Summary has been shortened and formulated more clearly
77	38874	6	3	1	0	0	Executive Summary: this summary is written in a very technical language and the most relevant information is included in the last paragraph of 17 paragraphs. It is likely that most people do not read all paragraphs and therefore will loose the most relevant paragraph. It is strongly suggested to rewrite the Executive Summary in order to align it with the structure and type of language with other executive summaries, e.g. chapter 8 offers a very good example of how to structure and word an executive summary. (Klaus Radunsky, Umweltbundesamt)	agreed, the Executive Summary has been shortened and formulated more clearly, the sequence rearranged.
78	41703	6	3	1	0	0	The executive summary is too long, e.g. the "microbial" part. (Rui Zhang, Xiamen University)	agreed, the Executive Summary has been shortened and formulated more clearly, the sequence rearranged.
79	52856	6	3	1	0	0	Executive Summary All but one of the statements deal with responses/impacts by/on the marine system; the one statement which addresses responses discusses geoengineering approaches; the ES needs to be more balanced in its coverage of responses/impacts and adaptation-related measure (e.g. infisheries) (John Hay, University of the South Pacific)	agreed, the Executive Summary has been shortened and formulated more clearly, the sequence rearranged. The balance of responses/impacts with adaptation has been improved
80	44191	6	3	1	7	43	The length of executive summary seems that of a paper, not a summary. (RONGSHUO CAI, Third Institute of Oceanography)	agreed, the Executive Summary has been shortened and formulated more clearly, the sequence rearranged.
81	39148	6	3	1	7	45	The executive summary is still difficult to read for a non-expert, and is full of jargon (eg. what is a heterotroph?). Who is your audience? Certainly, if you are talking to "executives" they will log off after a few sentences unless they are directly involved with portfolios where ocean science is a prerequisite. In short, your receptive audience will be experts only. Is that your aim? (admittedly, the absence of figures in the draft reduces readability, which will not be so in the final report). NB This comment appplies to many of the natural science-based chapters of the report. (Thomas Reuter, University of Melbourne)	agreed, the Executive Summary has been shortened and formulated more clearly, the sequence rearranged.
82	49056	6	3	1	7	45	Parts of the executive summary is very technical, and difficult to understand. Especially in the first to-tree pages the sections are very long and seems to try to explain more than to describe the current situation. The sections in the last two pages of the executive summary is in much better shape. (Oyvind Christophersen, Climate and Pollution Agency)	agreed, the Executive Summary has been shortened and formulated more clearly, the sequence rearranged.
83	36492	6	3	3	3	4	This chapter addresses climate change impacts on the oceans and on ocean dependent human systems. Regional impacts are dealt with in Chapter 30. (Keith Brander, DTU)	agreed
84	38516	6	3	6	3	10	This is a complicated, runon sentence. Terrible way to start your chapter. (Andrew Pershing, University of Maine)	agreed, sentence rewritten, broken up according to "temperature-oxygen-CO2&OA-ice melt-salinity" AND "nutrient concentration-light regime-food avaliablity for hetreotrophic organism"
85	54384	6	3	6	3	12	Regarding the traceable account for this finding, the content and assignment of calibrated language is clearly supported in the cited sections. I notice, however, that in section 6.1.1.5, conclusions related to specific factors mentioned in this finding are assigned likelihood language (e.g., rising temperature means and extremes, expansion of hypoxic or anoxic zones). While the use of a level of confidence (with evidence and agreement as a basis) seems appropriate, given the synthesis across a number of factors, not all of which have been assigned likelihood language, I was not completely sure of the relationship between these assignments in the chapter text and those in the Executive Summary. Changes may not be necessary if these fit together with a clear rationale, but I wanted to point at that it was not completely clear to me at this stage. (Michael Mastrandrea, IPCC WGII TSU)	Executive summary has been shortened and reordered. The specific use of calibrated language has been improved.
86	40408	6	3	6	7	45	In general, the Executive Summary focuses primarily on physiological responses of marine organisms, with much less consideration of ecological changes and changes to human uses of the oceans. There should be more even emphasis on each of these major classes of change, as well as an emphasis on changes in the physical and chemical ocean system. What about other human uses (in addition to fishing), such as changes in marine transportation, etc.? (Laura Petes, National Oceanic and Atmospheric Administration)	agreed, the Executive Summary has been shortened balanced and formulated more clearly, the sequence rearranged. However, our focus is on WGII issues, physical and chemical aspects are dealt with by WGI.
87	43006	6	3	7	3	8	I would question whether "and associated ammonia and sulfide levels" should be included, particularly as this is the first point in the Exceutive Summary. Increased ammonia & sulfide will only occur in anoxic waters which only represent a small volume of the ocean, whereas inclusion here infers that this will be a primary feature of climate change affects in the ocean (Cliff Law, NIWA)	We excluded "and associated ammonia and sulfide levels" because we agree this is not relevant in this very general context.
88	38517	6	3	8	0	0	When I see the word "stocks" I think fish or cattle, not nutrients. Nutrient concentrations? Levels? (Andrew Pershing, University of Maine)	Yes, "nutrient concentrations" is more adequate
89	36493	6	3	9	0	0	what is food availabilty? (Keith Brander, DTU)	We specified "food availability" on p. 4. As we think that the standing meaning of "food availability" is clear, we think that after this early definition its meaning is also clear in the context that it is used in different sections of the chapter.
90	54385	6	3	14	3	20	Regarding the traceable account for this finding, while I do see a general conclusion about the current rate of change being unprecedented in at least the last 300 Myr in section 6.1.2, I do not see the specific point about the current rate being an order of magnitude faster than during the PETM. This would be useful to clarify in the chapter text. (Michael Mastrandrea, IPCC WGII TSU)	agreed, the traceability has been improved.
91	38046	6	3	15	3	15	Present rates - What time period is in view? I assume century scale. (Ronald Stouffer, Geophysical Fluid Dynamics Laboratory/NOAA)	agreed, balanced with chapter text, time frame included more precisely
92	50310	6	3	15	3	15	It may be helpful to further clarify what is meant by "key environmental drivers involved"--involved in current changes, in past regime shifts in ocean ecosystems, or in both? (Katharine Mach, IPCC WGII TSU)	common drivers are now named

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
93	47624	6	3	15	3	16	The statement is not consistent with the best science. Present climate change is certainly not faster than the planet-killing bollide at the K-T boundary 65MYA, or any other bollide, and potentially various super-volcanow eruptions. (John Dunne, NOAA/GFDL)	We formulate more precisely now and emphasize that the rate comparison refers to anthropogenic CO2 release. PETM at 55MYA is most comparable to present change and not elicited by a bollide impact. The Svalbard succession has a 300 m thick Paleogene interval with a 40 meter long PETM section. The duration of the PETM is 150kyrs, hence the resolution is 25 cm per or 2.5 cm per 100 years to address the question the reviewer asked. The very well studied new Jersey section has 10 meter for the PETM (though the duration is truncated as there is an unconformity at the top) so a resolution just around centennial. The current estimates for the fastest possible input is around 1000 years with up to 10.000 years. So if the input would have happened faster than the 1000 years which then would relate to the faster than 10 times, we would be able to see this. There are very detailed analyses of carbon isotopes for both sections which would have indicated a perturbation of the carbon cycle. No bolide impact, while causing climate change has been unequivocally been asscoiated with ocean acidification.
94	46874	6	3	16	3	16	"linked to" - is this saying that current climate change is linked to 10 x faster CO2 accumulation? If so, can't it just say that CO2 accumulation is 10 x faster rather than saying climate change is 'linked' to this? (Genevra Harker, HarmonicQuay Ltd)	We formulate more precisely now and emphasize that the rate comparison refers to anthropogenic CO2 release
95	43004	6	3	16	3	17	the phrase "linked to" is confusing and redundant; also as this is the Excutive Summary the PETM needs to be given some context - if this is the period of time when rapid change was most recent and/or greatest then this should be stated (Cliff Law, NIWA)	We formulate more precisely now and emphasize that the rate comparison refers to anthropogenic CO2 release
96	47274	6	3	16	3	17	The 10X faster inference is probably true but I doubt this can be assigned high confidence. The current transient is happening at a very high rate, and rates in distant past climates are known only approximately over short time scales. What sort of data records from the PETM have a resolution of 100 years or less? (James Christian, Government of Canada)	We have added that rates for PETM are average rates. We cannot exclude that short term rates may have been higher.
97	36494	6	3	22	0	0	”virtually” should not be used here – what, if anything does it mean? (Keith Brander, DTU)	The word virtually has been deleted
98	48428	6	3	22	3	23	Does the "very high confidence" attributed to this statement does not properly reflect the extent to which observed changes due to climate change relative to climate variability? I am doubtful since very long time-series are needed for this (e.g., Henson et al., 2010; Detection of anthropogenic climate change in satellite records of ocean chlorophyll and productivity, Biogeosciences, 7 (2) DOI: 10.5194/bg-7-621-2010). Saying that marine ecosystems have been observed to respond strongly to climate change and variability is certainly true, but restricting it to climate change presents a higher bar to jump over. (Charles Stock, NOAA/Geophysical Fluid Dynamics Laboratory)	We agree that climate change may involve climate variability. To make this clear we added the term variability. We also agree on the need for long time series to identify anthropogenic change. The Henson et al paper is now cited in 6.1.3.
99	40409	6	3	22	3	27	What about changes in abundance and survival? (Laura Petes, National Oceanic and Atmospheric Administration)	This section has been lost from the executive summary of the SOD but its content is now included and complemented in the chapter text, e.g. 6.2.2.
100	47625	6	3	23	3	23	The first response listed should be the growth response, for a total of 4 types. (John Dunne, NOAA/GFDL)	This section has been lost from the executive summary of the SOD but its content is now included and complemented in the chapter text, e.g. 6.2.2.
101	50311	6	3	23	3	25	Because the list of responses in this sentence is not inclusive of all types of responses, it may be clearest to use a phrase such as "major types" instead of "kinds." (Katharine Mach, IPCC WGII TSU)	This section has been lost from the executive summary of the SOD but its content is now included and complemented in the chapter text, e.g. 6.2.2.
102	36495	6	3	26	3	27	Not clear what this is adding to the meaning. (Keith Brander, DTU)	This section has been lost from the executive summary of the SOD but its content is now included and complemented in the chapter text, e.g. 6.2.2.
103	36496	6	3	29	0	0	Not clear what ”These” refers to. (Keith Brander, DTU)	This section has been lost from the executive summary of the SOD but its content is now included and complemented in the chapter text, e.g. 6.2.2.
104	43005	6	3	33	3	35	This sentence may be correct but it is a little confusing and perhaps unnecessary to include that biological processes feedback upon oxygen depletion & acidification in the Excec Summary (Cliff Law, NIWA)	This section has been lost from the executive summary of the SOD but its content is now included and complemented later in the execuive summary and in the chapter text, e.g. 6.2.2. In line with the chapter outline we feel that this feedback is essential to our message. It is essential to the non-expert that physical and biological change combine to cause oxygen depletion. Furthermore, it represents one of the few certainties from the microbal world.
105	47626	6	3	35	3	35	Grammar needs work - 'though' needs a comma or something for meaning. (John Dunne, NOAA/GFDL)	agreed, but sentence has been lost

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
106	38518	6	3	35	3	37	I don't understand this sentence. I think the jargon term upscaling is confusing me. (Andrew Pershing, University of Maine)	agreed, but sentence has been lost
107	47627	6	3	37	3	37	add “as the circulation and nutrient supply changes are highly uncertain (e.g. steinacher), and” (John Dunne, NOAA/GFDL)	agreed and included, see 108
108	52511	6	3	38	0	0	Insert ...physical change are extremely diverse ... and often modulated by non-linear biological interactions. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	agreed and included, see 107
109	50312	6	3	39	3	39	Even if in very broad terms, the chapter team could indicate more specifically what is meant by "such," given that many processes have been mentioned already in the paragraph. (Katharine Mach, IPCC WGII TSU)	word has been lost in the revision process
110	52512	6	3	41	0	0	comment on biological modulation might help (see above) (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	agreed; this statement has now been integrated into the text.
111	52513	6	3	45	0	0	should phenotypic and genotypic responses be highlighted? (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	agreed and better integrated in the text
112	47628	6	3	45	3	45	I know of no direct evidence for this limit. With respect to microbes, what is the evidenced that the anticipated thermal changes will ‘challenge their thermal tolerance’? I know of enzymatic constraints at >35C, and evidence that individual species/cultures have ranges, but this is a long time in microbe world. (John Dunne, NOAA/GFDL)	You are right, there don't seem to be comprehensive publications yet on this topic. We are currently analysing literature and present a synthesis figure in the SOD. We now emphasize species specific responses.
113	50313	6	3	48	3	48	It is not completely clear what is meant by the word "qualified"--altered? (Katharine Mach, IPCC WGII TSU)	The word qualified has been lost from the chapter
114	46875	6	3	49	3	49	"heterotrophic bacterial" - should this be bacteria, or is there a word missing after bacterial? (Genevra Harker, HarmonicQuay Ltd)	This aspect is dealt with in the text with different wording and has been lost for the Executive Summary.
115	36497	6	3	54	0	0	does ”may have increased” refer to an observed or a projected state? (Keith Brander, DTU)	This aspect is now dealt with in the text where it is clear that this sentence is written in past tense because it refers to an observation. It refers to information in 6.2.3.
116	50314	6	3	54	3	54	As possible, it would be helpful to clarify the relevant time frame for this potential increase in productivity (over how many decades, for example). (Katharine Mach, IPCC WGII TSU)	This aspect is now dealt with in the text where it is clear that this sentence is written in past tense because it refers to an observation. It refers to information in 6.2.3. and provides a timeframe.
117	50318	6	4	1	4	1	As possible, it would be helpful to clarify the relevant time frame for the observations described on this line. (Katharine Mach, IPCC WGII TSU)	this aspect no longer covered in the chapter
118	50315	6	4	4	4	7	For the statements, the author team might consider also presenting summary terms for agreement. (Katharine Mach, IPCC WGII TSU)	this aspect no longer covered in the Exec Summary
119	52514	6	4	5	0	0	...light regimes but have there is limited evidence and we have low confidence (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	this aspect no longer covered in the Exec Summary
120	37177	6	4	7	0	0	“Warming may both increase the grazing rate of zooplankton etc.” This is misleading - the metabolic rate of zooplankton depends on temperature, but the grazing rate is much more dependent on food concentration. I would write: “Warming may affect the size composition of both phytoplankton and zooplankton communities and increase their physiological rates.” (Erica Head, Fisheries and Oceans Canada)	This detail is lost in the revised executive summary. We would now write "With ample food available warming may both increase the grazing rate of zooplankton and cause a reduction in phytoplankton body size (medium confidence)."
121	37178	6	4	10	0	0	“NPP is expected to change in the future, with regional differences, and to increase at high latitudes” As written, I think this is misleading, at least for the northern hemisphere. NPP will only increase at high latitudes so long as light is the factor limiting phytoplankton growth, due to ice cover, or deep mixed layer depths. NPP will not increase indefinitely, since nutrient supply is likely to become the limiting factor in the long-term. Maybe better phrasing would be “NPP is expected to change in the future, with regional differences, with an increase at high latitudes” (Erica Head, Fisheries and Oceans Canada)	The concerns are well taken. Environmental controls like nutrients are now mentioned..
122	47629	6	4	10	4	10	This statement runs counter to the state of the science. Ocean NPP is more like one quarter if recent ocean estimates of global productivity (36-78 PgC a-1; Carr et al. (2006) and land estimates (150–175 PgC a-1; Welp et al., 2011) are to be believed. Welp, L. R., R. K. Keeling, H. A. J. Meijer, A. F. Bollenbacher, S. C. Piper, K. Yoshimura, R. J. Francey, C.E. Allison, and M. Wahlen, 2011: Interannual variability in the oxygen isotopes of atmospheric CO2 driven by El Niño, Nature, 477, 579-582. (John Dunne, NOAA/GFDL)	We have checked and confirmed that the original estimate is still the one agreed on by the community.
123	50316	6	4	10	4	12	I am not sure I completely understand the logic of the 2nd and 3rd sentences presented here in bold. The 2nd sentence indicates that NPP is expected to change with high confidence, while the 3rd sentence indicates low confidence in numerical predictions. I'm wondering if the 2nd sentence pertains to understanding of future changes, while the 3rd pertains to modeling of observed changes? It would be helpful to further clarify the distinction between these 2 sentences and the confidence assignments made. (Katharine Mach, IPCC WGII TSU)	Exactly, the changes expected cannot be quantified with high certainty. This whole paragraph has been rephrased accordingly.
124	48429	6	4	10	4	13	Need to be more specific concerning what constitutes "high latitude" and "low latitude". This applies throughout the chapter. (Charles Stock, NOAA/Geophysical Fluid Dynamics Laboratory)	Point taken, high complemented with polar here, but certainly there are transients and a sharp regional distinction is not possible.
125	54387	6	4	10	4	18	Regarding the traceable account for this finding, this is an example where some of the calibrated language assignments in section 6.5.1 do not quite match those in the Executive Summary. For example, the section states medium agreement and confidence that primary production will decrease by 2100, with limited evidence suggesting an increase. The Executive Summary states low confidence for a decrease by 2100, and it is not clear whether this is an intentional difference and if so why there is the difference. Further clarity in these types of situations would be very helpful. (Michael Mastrandrea, IPCC WGII TSU)	We now checked to make sure that the qualifiers of the uncertaintly language match between the executive summary and the other sections.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
126	36498	6	4	12	0	0	confusion over whether we are dealing with prediction or observation here (Keith Brander, DTU)	Uncertainties in observations and the resulting uncertainties in projections have now been clearly addressed when reformulating this paragraph.
127	36499	6	4	13	4	18	confused. The last sentence does not seem consistent with the second last. See also comment 1 above. (Keith Brander, DTU)	This whole paragraph has been reformulated for consistency.
128	38519	6	4	14	0	0	"global primary production will change (high probability)" Please delete the high probability and just describe the change (Andrew Pershing, University of Maine)	This whole paragraph has been reformulated for consistency.
129	52515	6	4	16	0	0	.... Scenarios (Should read). There is limited evidence and low agreement on the direction, magnitude and regional differences of global change of NPP in the open ocean as well as in coastal waters, low confidence for a decrease by 2100. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	This whole paragraph has been reformulated for consistency.
130	37179	6	4	20	0	0	“Complex (macro)-organisms etc” Is this paragraph talking about ectotherms, endotherms or both? It should be stated, for clarity. (Erica Head, Fisheries and Oceans Canada)	This whole paragraph has been reformulated for consistency.
131	38520	6	4	20	0	0	I don't like the term "water breathing." Nothing breathes water, everything breathes oxygen. With the exception of mammals and birds, everything in the ocean extracts oxygen from water. Unless it's absolutely necessary, please just call them animals. (Andrew Pershing, University of Maine)	This whole paragraph has been reformulated for consistency. The terms have been changed to "breathing in water" versus "breathing in air" in the text.
132	38521	6	4	20	0	0	"animals including zooplankton, seaweeds, and seagrasses"--seaweeds and seagrasses are not animals! (Andrew Pershing, University of Maine)	This whole paragraph has been reformulated for consistency.
133	40410	6	4	20	0	0	Why focus on the phrase "water breathing?" That is not a commonly used phrase in communicating about marine macroorganisms. Also, seaweeds and seagrasses are not "animals," so that needs to be corrected. (Laura Petes, National Oceanic and Atmospheric Administration)	This whole paragraph has been reformulated for consistency. The terms have been changed to "breathing in water" versus "breathing in air" but only used in the text.
134	52516	6	4	20	0	0	(should read) water respiring animals..... (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	This whole paragraph has been reformulated for consistency. The terms have been changed to "breathing in water" versus "breathing in air" but only used in the text.
135	47275	6	4	20	4	20	seaweeds and seagrasses are animals? (James Christian, Government of Canada)	This whole paragraph has been reformulated for consistency. The terms have been changed to "breathing in water" versus "breathing in air" but only used in the text.
136	54388	6	4	20	4	29	Please provide line of sight for this finding. (Michael Mastrandrea, IPCC WGII TSU)	This whole paragraph has been reformulated for consistency. The terms have been changed to "breathing in water" versus "breathing in air" but only used in the text. We added [6.2.2] as a reference.
137	40411	6	4	24	0	0	"Sluggish" is not a good way to describe marine animals throughout this chapter. Perhaps say "slow-moving" or "sessile" (depending on what you're referring to)? Also, would be better to focus on ectothermic/endothermic (cold-blooded vs. warm-blooded if want to use laymen's terms) than "water breathing," which again, doesn't really make sense. (Laura Petes, National Oceanic and Atmospheric Administration)	This whole paragraph has been reformulated for consistency. We replaced the term "sluggish" with "slow-moving and sessile" animals.
138	41733	6	4	24	4	24	What is exactly meant by "sluggish lifeform"? (Juergen Weichselgartner, University of Kiel)	The term sluggish replaced by sessile in text, otherwise this whole paragraph has been rephrased.
139	40412	6	4	25	4	27	This doesn't apply to tropical organisms, such as corals, that can experience bleaching with only a 1C warming greater than average mean max temp. (Laura Petes, National Oceanic and Atmospheric Administration)	Looking at the whole temperature range tolerated by a species is different from asking where in ist thermal window the animal actually lives and whether as in the case of some corals they actually live close to their upper thermal limits. We have rephrased this section to make this clearer.
140	35249	6	4	29	0	0	Insert "tropical" between "among" and "macrophytes" (Christian Wiencke, Alfred Wegener Institute)	Sentence has been amended and moved to main text.
141	37180	6	4	31	0	0	“For marine water breathing animals etc” Is this paragraph talking about ectotherms, endotherms or both? It should be stated, for clarity. (Erica Head, Fisheries and Oceans Canada)	All "water-breathing animals" are ectothermic animals. The term ectotherms is added in brackets as an additional qualifier. However, a key point is that they breathe in water rather than in air. However, this whole paragraph has been condensed during the shortening exercise.
142	47630	6	4	39	4	40	What is 'the concept' to which is being reffered, 'thermal windows'? The sentence seems extraneous. (John Dunne, NOAA/GFDL)	We would now write "The OCLTT concept " however, the section on physiological knowledge hase been shortened and rewritten in a more general way.
143	50317	6	4	43	4	43	It may be beneficial to indicate more explicitly the timeframe relevant to the understanding provided through mechanistic insight. That is, it seems the author team is saying mechanistic insight allows understanding of how animals have been and will be affected--past and future--which could be clarified further. Alternatively, if the focus here is primarily forward-looking, the relevance of mechanistic insight in the context of understanding and projecting future outcomes could be emphasized further. (Katharine Mach, IPCC WGII TSU)	The section on physiological knowledge hase been shortened and rewritten in a more general way. We have emphasized that it helps to understand changes in the past, present and future.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
144	52517	6	4	46	0	0	Once warming temperatures approaches their tolerance limits of species they will be unable to migrate to cooler waters, Antarctic species in particular possess limited capacity to acclimate.... (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	The first part of the suggested sentence is generalizing beyond current knowledge, wording for the second part has inflenced the text section as this information was moved out of executive summary.
145	47631	6	4	46	4	46	Certainly true for ice-associated ecosystems, but hard to say that winter temps will be much higher. More accurate to say that the coldest ecosystems may be put at a competitive disadvantage. (John Dunne, NOAA/GFDL)	We included as a consequence in the body of the text, that the coldest ecosystems may be put at a competitive disadvantage.
146	46876	6	5	3	5	3	"mostly bacteria both create specialized..." - is the mostly bacteria an example of the heterotrophic organisms? If so, needs an extra comma. It isn't clear what the 'both' refers to as a list of three parameters is given. (Genevra Harker, HarmonicQuay Ltd)	This section has been revised and sentence lost.
147	35928	6	5	9	0	0	Is it possible to also state growth rate in low oxygen environments is slow (reduced productivity)? (Frank Whitney, Institute of Ocean Sciences)	We now emphasize this in the main body of text 6.3.3. and refer to that infomation in the executive summary.
148	41734	6	5	9	5	9	one page earlier (see previous comment) it is spelled "lifeforms", and now "life forms". Should be constistent (Juergen Weichselgartner, University of Kiel)	we assured consistency, "life forms"
149	43007	6	5	17	5	17	"Ocean acidification causes marine organisms to take up accumulating CO2 passively by diffusion...." needs redrafting for clarity: - "marine organisms take up CO2 passively by diffusion and so the increase in dissolved CO2 (ocean acidification) leads to permanently elevated internal CO2...." (Cliff Law, NIWA)	We now emphasize this in the main body of text 6.2.2.. and refer to that infomation in the executive summary.
150	47632	6	5	22	5	22	need comma before 'and the sensitivity' (John Dunne, NOAA/GFDL)	Sentence lost in the editing and condensation process.
151	52518	6	5	24	0	0	(should read) ... and may as a result be more sensitive... (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Sentence lost in the editing and condensation process.
152	43008	6	5	24	5	24	words missing in "and may result more sensitive" (Cliff Law, NIWA)	Sentence lost in the editing and condensation process.
153	47633	6	5	24	5	24	change 'may result' to 'may as a result become' (John Dunne, NOAA/GFDL)	Sentence lost in the editing and condensation process.
154	47634	6	5	28	5	28	add comma after 'phytoplankton' (John Dunne, NOAA/GFDL)	Sentence lost in the editing and condensation process.
155	54386	6	5	28	5	38	Regarding the traceable account for this finding, it appears that some of the relevant discussion occurs in section 6.2.2.3. This is an example where I did not see a direct link for the medium confidence assignment in the bold sentence to one in the chapter text, because it synthesizes across sections. Along the lines in my general comment, it might be worth considering presenting such a link in section 6.2.2.5. In addition, a minor point, but please check the calibrated uncertainty language in the last sentence of the finding, which mentions limited evidence, low agreement, low confidence, while a similar sentence in 6.2.2.2.5 mentions limited evidence and medium agreement, low confidence. (Michael Mastrandrea, IPCC WGII TSU)	We now assured that uncertaintly language matches more precisely between the executive summary and the individual points of the text sections.
156	50319	6	5	41	5	41	As a minor point, it might be clearest to specify more precisely the nature of the relationship between sensitivity and the described capacity--for example, sensitivity may decrease with increasing capacity...? (Katharine Mach, IPCC WGII TSU)	agreed, wording adopted. Now reads..." sensitivity decreases with increasing capacity"
157	37181	6	5	44	0	0	"Feeding status supports individuals etc." Surely this should be "A good feeding status supports individuals etc." (Erica Head, Fisheries and Oceans Canada)	We now emphasize this in the main body of text . and refer to that information in the executive summary.
158	52519	6	5	44	0	0	(should read) Nutritional status enables... (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We now emphasize this in the main body of text and refer to that information 6.2.5. in the executive summary.
159	47635	6	5	44	5	45	Should there be an 'Adequate' before 'feeding status'? Not sure of the meaning here. (John Dunne, NOAA/GFDL)	We now emphasize this in the main body of text and refer to that information 6.2.5. in the executive summary.
160	38522	6	5	46	0	0	"constrain the dimensions of climate dependent..." First, add a hyphen in climate-dependent. Second, I don't understand what you mean by constraining the dimension. Are there fewer dimensions (i.e. 3D to 2D) or is the range smaller? (Andrew Pershing, University of Maine)	We now emphasize the narrowing of the range in the main body of text and refer to that information 6.2.5. in the executive summary.
161	47636	6	5	53	5	54	This is an unproven assertion, though widely espoused by environmentalists. There has been no statistically robust trend analysis much less a detection and attribution study relating to temperature much less climate forcing. The only thing one can say is that there have been more reports of bleaching recently. This is because there are no 'no-bleaching reports' from the past with which to test the null hypothesis, but lots of recent bleaching observations. Attribution to temperature variability is only 20-50% as other factors dominate. (John Dunne, NOAA/GFDL)	Text was adjusted. We now specify this point more to the specific areas where senstitive species and reefs were found and to the correlation with temperature. We agree that some studies found more resilient corals. The net global affect is a reduction of coral cover and loss of resilience of the reef ecosystem.
162	40413	6	6	1	0	0	Is this 1-2% a global average? Across what time period? This makes it seem like bleaching is slow, when really, mass bleaching events also occur. Need to clarify that (at least clarify what this statistic is referring to). (Laura Petes, National Oceanic and Atmospheric Administration)	Agreed, the average rate should not be mistaken in that extreme events caused mass bleaching. Wording improved.
163	50320	6	6	1	6	1	For this described decrease in live coral cover, it may be helpful to clarify the role of non-climate stressors in addition to increased temperature extremes. (Katharine Mach, IPCC WGII TSU)	We now emphasize this in the cross-chapter box on coral reefs and refer to that information in the executive summary.
164	46877	6	6	4	6	4	"it will likely occur" - please use 'it will probably occur' or 'is it likely to occur'. (Genevra Harker, HarmonicQuay Ltd)	This section has been revised and sentence lost.
165	50321	6	6	4	6	6	For this projected increase in bleaching, the author team could consider clarifying 2 points. 1st, what is the spatial extent of the bleaching described here? 2nd, what are the differences in bleaching that are projected across scenarios of climate change--given that the outcome characterized here is for moderate warming? Also, it would be great to name the relevant climates/socio-economic scenarios as appropriate (SRES or RCP). (Katharine Mach, IPCC WGII TSU)	We now emphasize this in the cross-chapter box on coral reefs and refer to that information in the executive summary.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
166	37182	6	6	9	0	0	“symbioses” should be “symbionts” (Erica Head, Fisheries and Oceans Canada)	Most recent evidence indicates that thermal tolerance of the coral is not necessarily set by the thermal tolerance of the symbionts per se but by the functioning of the symbiosis. The host also plays a role here. We feel that our wording is the most appropriate in light of this insight. We now emphasize this in the main body of text and refer to that information 6.2.5. in the executive summary.
167	47637	6	6	13	6	13	‘What is meant here by ‘synergistically’ - Temperature increase actually counteracts acidification on aragonite saturation state. (John Dunne, NOAA/GFDL)	We specified that we mean the synergistic action of temperature extremes with ocean acidification in the text.
168	47638	6	6	18	6	18	This asserted lack of sensitivity is not strictly true as acidification increases sound propagation in water, so hearing and communication are effected. (John Dunne, NOAA/GFDL)	There is evidence for increased sound propagation but no evidence for any such effect on biology yet. We have included this information, mentioning the appropriate uncertainty level. In a way, this is a background phenomenon that may affect fishes too.
169	47116	6	6	20	6	22	Why is only sea ice listed as an example of habitat stucture? What about sea turtle nesting beaches or bird breeding grounds that are both not a function of sea ice? (Vincent Saba, NOAA National Marine Fisheries Service)	We added "e.g., " before sea ice to indicate this is just one example, and coastal habitats in general, although this would be dealt with in the Coastal chapter.
170	48430	6	6	22	6	26	The level of specificity here seems incongruous with the rest of the executive summary - was there a reason why these particular results were highlighted? (Charles Stock, NOAA/Geophysical Fluid Dynamics Laboratory)	This detail is taken out of the Executive summary and kept in the text of 6.5.2.
171	47117	6	6	25	6	26	There is also published work for range expansion for leatherback turtles in the Atlantic (McMahon, C. R. & Hays, G. C. Thermal niche, large-scale movements and implications of climate change for a critically endangered marine vertebrate. Glob. Change Biol. 12, 1330–1338 (2006)). (Vincent Saba, NOAA National Marine Fisheries Service)	We happily included the new study on this important group in the text of 6.2.2..
172	35929	6	6	30	6	34	Demersal fish migration may be driven by hypoxia in the N Pacific at rates much quicker than warming would anticipate (Koslow et al 2011; McClatchie et al., 2010). Also, Polovina et al (2011) suggest an increase in subtropical fish production based on their model results (forced by a northward shift in the Westerly winds and hence an expanding subtropical domain), and a reduction in temperate production. Koslow, J.A., Goericke, R., Lara-Lopez, A. & Watson, W. Impact of declining intermediate-water oxygen on deepwater fishes in the California Current. Mar. Ecol. Prog. Ser. 436, 207-218 (2011). McClatchie, S et al. Oxygen in the Southern California Bight: Multidecadal trends and implications for demersal fisheries. GEOPHYSICAL RESEARCH LETTERS, VOL. 37, L19602, doi:10.1029/2010GL044497, 2010 (Frank Whitney, Institute of Ocean Sciences)	The interference of hypoxia by an acceleration of shifts is an interesting notion that we now consider in the temperature hypoxia interaction section 6.3.5..
173	37183	6	6	34	0	0	Should “sub-Arctic” be “sub-polar”? Also, I think this statement is a bit misleading. Sub-Arctic (or sub-polar) regions might be expected to have extinctions, but the number of invading species is likely to exceed the number of extinctions. So should this statement be: “As a result, high latitude regions (the Arctic and Southern Ocean) are projected to have high rates of species invasions, while sub-Arctic and sub-Antarctic regions are likely to have both species invasions and extinctions (or extirpations), and tropical regions and semi-enclosed seas are expected to have high rates of local extinctions.” (Erica Head, Fisheries and Oceans Canada)	This detail is taken out of the Executive summary. We now emphasize this in the main body of text in 6.3.2.
174	38752	6	6	36	0	0	I suggesto to change the order of this sentence as: Large fluctuations in ecosystem structure and fish stock are linked to the variability of oceanographic conditions (Ricardo Anadon, University of Oviedo)	This formulation is taken out of the Executive summary.
175	41735	6	6	36	6	52	The idea that variability in oceanographic conditions is linked to changes in ecosystem and fish stocks is important and valid, but can it be stated in without mentioning the role of overfishing (on page 7, line 19, it is mentioned as one of many human-induced drivers)? Overfishing will also cause shifts in species distributions and size as well as changes in ecosystems and may be the most important anthropogenic driver to these changes. (Juergen Weichselgartner, University of Kiel)	The interaction of the outlined patterns with other human impact such as overfishing is now included.
176	50322	6	6	45	6	45	Here it may be clearest to use the word "reduce" instead of "alter" if this meaning is what is intended. (Katharine Mach, IPCC WGII TSU)	agreed and adopted
177	47639	6	6	52	6	52	Pointing out hypoxia and then stressing sensitivity of high latitudes does not make sense, as the causation does not follow since there is little to no hypoxia at high latitudes nor is there projected to be. (John Dunne, NOAA/GFDL)	This is a misunderstanding as the term hypoxia does not refer to high polar latitudes. Wording has been changed during editing of executive summary
178	50323	6	6	52	6	52	Although present tense is used for the verb on this line, it seems it may be a future-looking (projection-oriented) statement. If so, it could be beneficial to clarify the relevant general time frame. (Katharine Mach, IPCC WGII TSU)	This formulation is taken out of the Executive summary.
179	54393	6	7	0	7	31	Regarding the traceable account for this finding, this is an example where some of the calibrated language assignments in section 6.5.1 do not quite match those in the Executive Summary. For example, the section states robust evidence, high agreement and very high confidence that climate change impacts marine ecosystems and their services, while the Executive Summary does not include the confidence assignment. (Michael Mastrandrea, IPCC WGII TSU)	We now assured that uncertaintly language matches between the executive summary and the other sections.
180	35930	6	7	1	7	7	Comments above should be considered when revising this paragraph. For example, increased productivity in temperate oceans may favor e.g. tuna rather than salmon in the N Pacific (Polovina et al. 2011) (Frank Whitney, Institute of Ocean Sciences)	We include the more specific information in the related text section.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
181	36500	6	7	1	7	7	Ascribing high confidence or even medium confidence to quantitative estimates of changes in fisheries yields seem inconsistent with sections 6.5 to 6.5.3, 6.4.1.1.1. lines 23-28, 6.4.1.1.2 lines 42-45. It is also inconsistent with the modeling and confidence evaluation used by WG1 for making climate predictions, because it relies on only one structurally incomplete model. It is inconsistent with the treatment of confidence levels in ch 18 and with their specific comment on NPP (18.3.4.2). (Keith Brander, DTU)	The referee may have overlooked our explicit statement that quantitive estimates come with medium to low confidence. Nonetheless, we now made sure that uncertaintly language matches between the executive summary and the related sections as well as chapter 18 where we are contributing authors.
182	48431	6	7	1	7	7	p. 4, lines 10-18 states that there is limited evidence, low agreement, and low confidence for a decrease in NPP by 2100. The high confidence given to the redistribution of global catch potential here is at odds with this previous statement. This needs to be reconciled. (Charles Stock, NOAA/Geophysical Fluid Dynamics Laboratory)	We now assured that uncertaintly language matches between the two parts of the the executive summary and the other sections.
183	38753	6	7	2	0	6	I suggest to incorporate : ….NPP occurs, and depending on management practices, overall fisheries …… My feeling is that new	This important comment has been included here and now been
184	47640	6	7	3	7	3	add a comma after 'displacements' Also, 'low latitudes' should point out the equatorial and coastal regions as probable exceptions (Polovina, J J., John P Dunne, P A Woodworth, and E A Howell, July 2011: Projected expansion of the subtropical biome and contraction of the temperate and equatorial upwelling biomes in the North Pacific under global warming. ICES Journal of Marine Science, 68(6), DOI:10.1093/icesjms/fsq198.) (John Dunne, NOAA/GFDL)	Message has been reformulated accordingly, biome expansion vs. contraction mentioned in the main body of text, 6.5.. The Polovina et al. (2011) paper looks at changes in primary production and the boundary of biogeographic biomes, but not distribution of species (particularly higher trophic level). So, it does not provide evidence for the claim that the reviewer suggested. Also, the statement that we made in the sentence is talking about global average, and it is valid based on available evidence that we presented in the text. The confidence statement is now specified: medium confidence for the occurrence of changes in global catch potential, low confidence for the magnitude of change
185	50324	6	7	3	7	3	It would be clearest to indicate more specifically what "it" refers to--fisheries catch potential? (Katharine Mach, IPCC WGII TSU)	amended in the reformulation
186	50325	6	7	5	7	5	For the projected drop in yield described here, it would be preferable to indicate more fully the range in the projected decrease, as done for the projected increase. (Katharine Mach, IPCC WGII TSU)	amended in the reformulation in executive summary and text
187	38240	6	7	9	7	11	Executive Summary. "Observations show enhanced ocean upwelling in Californian, Humboldt and Canary eastern boundary systems, which produce cooler surface waters associated with enhanced productivity, but unclear trends for higher trophic levels in those areas (medium confidence)." This finding will have an important impact on the national economy and food security. Question: Is there any potential relationship between enhanced productivity and warm/cold ocean currents? (Abdalah Mokssit, Direction de la Météorologie Nationale (DMN))	Cold upwelling waters will have higher nutrient concentrations and thereby support higher productivity. The impact on national economies and food security will be dealt with by the regional chapter.
188	35931	6	7	9	7	15	Consider suggestions by Koslow et al and McClatchie et al that oxygen levels determine habitat for groundfish. Enhanced upwelling will draw low oxygen waters onto the continental slope and shelf, enriching nutrients but decreasing viable deep habitat (Chan, F. et al. Emergence of anoxia in the California Current large marine ecosystem. Science 319, 920 (2008). (Frank Whitney, Institute of Ocean Sciences)	This is included in the executive summary by saying "in addition to hypoxia effects" and in the text body, now 6.2.5., 6.3.3.
189	42214	6	7	9	7	15	It is not correct to state that coastal upwelling has enhanced in the Canary eastern boundary. Several works (Lemos and Sansó, Journal of Geophysical Reserach 111, doi.org/10.1029/2005JC003051, 2006; Alvarez-Salgado et al., Harmful Algae 7, 849–855, 2008; Pérez et al., Global Change Biology 16, 1258–1267, 2010) have shown a decline of the extension and intensity of the upwelling season over the last 50 years in the Iberian upwelling, which is considered the northern boundary of the Canary eastern boundary upwelling system. (X. Anton Alvarez-Salgado, CSIC Instituto de Investigaciones Marinas)	Thank you, we have carefully checked this point and corrected the text accordingly acknowledging spatial heterogeneity.
190	52522	6	7	11	0	0	Iberian system? Any evidence? (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	This point has been checked and complemented.
191	47139	6	7	11	7	12	Change "…hypoxic and corrosive (high CO2) deep water" to "…"hypoxic and high CO2 deep water" because "corrosive" is only meaningful with respect to omega-calcite or omega-aragonite. Many of the harmful influences of high CO2 water are independent of its corrosivity to minerals. (Sarah Cooley , Woods Hole Oeanographic Institution)	agreed, wording adopted for the main text when addressing general CO2 effects.
192	54389	6	7	14	7	15	I would suggest rephrasing this sentence, as currently, it implies that the author team has low confidence that extrapolation to the global level is not possible. One option would simply be to remove the low confidence assignment here. (Michael Mastrandrea, IPCC WGII TSU)	Use of confidence assignment has been adjusted in the revised section.
193	47641	6	7	15	7	15	Text should note that model analysis suggests that upwelling areas will increase nutrient content and productivity under enhanced stratification (Rykaczewski, R, and John P Dunne, November 2010: Enhanced nutrient supply to the California Current Ecosystem with global warming and increased stratification in an earth system model. Geophysical Research Letters, 37, L21606, DOI:10.1029/2010GL045019.). (John Dunne, NOAA/GFDL)	This point is appropriately developed in the main text 6.1.1. where we added the suggested reference.
194	52521	6	7	17	0	0	(should read) - ... Climate change consists of multiple drivers (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	wording amended with the reformulation of executive summary
195	39016	6	7	17	0	21	I think that "dead zones" should be mentioned here (and perhaps on page 4 near the bottom, where low oxygen stress is first discussed). They don't get defined until page 12, line 19. (George Somero , Stanford University)	Point taken, we have developed this general section accordingly. We say, eutrophication exacerbates hypoxia here and mention dead zoneslater in the executive summary.
196	38523	6	7	17	7	20	Please simplify this statement (Andrew Pershing, University of Maine)	This section has now been reformulated with hopefully improved understandability.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
197	54390	6	7	17	7	21	It may be possible to merge this finding with the first one in the Executive Summary. (Michael Mastrandrea, IPCC WGII TSU)	The executive summary has been revised and the sections that can serve as introductory paragraphs have been moved upfront.
198	52523	6	7	18	0	0	- useful to distinguish global, regional and local drivers/impacts (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Drivers have now been specified as global versus local.
199	40414	6	7	18	7	26	These animals are also directly affected by changes in air or water temperature, not just indirectly through their prey. (Laura Petes, National Oceanic and Atmospheric Administration)	Wrong page, comment intended for page 6, lines 18 to 26. The direct impact of temperature on turtles is now emphasized.
200	47642	6	7	21	7	21	add comma after 'resources' (John Dunne, NOAA/GFDL)	Sentence lost in the editing and condensation process.
201	40415	6	7	23	0	0	Should insert word "ocean" prior to ecosystem services. (Laura Petes, National Oceanic and Atmospheric Administration)	agreed and adopted to specify services here and elsewhere.
202	38047	6	7	23	7	31	CO2 uptake by marine ecosystems is also a very important benefit to humans. (Ronald Stouffer, Geophysical Fluid Dynamics Laboratory/NOAA)	The sevice of climate regulation is specifically mentioned and detailed in the main text, 6.4.1.
203	41736	6	7	26	7	27	This sentence is unclear. Maybe sea level rise due to increasing ocean temperatures would be a better exmple? (Juergen Weichselgartner, University of Kiel)	Sentence lost in the editing and condensation process, but message is included in text body.
204	50326	6	7	28	7	28	"very likely" -- Both words of this likelihood term should be italicized. (Katharine Mach, IPCC WGII TSU)	Sentence lost in the editing and condensation process, but message is included in text body.
205	52524	6	7	31	0	0	- impacts on spread of species, trans arctic interchange. this last happened 3.8 - 4 million years ago. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Detail lost in the editing and condensation process, but message is now included in text body.
206	47140	6	7	33	7	33	Strike "conservation" before pressure? Seems confusing as worded… provides the initial impression OPPOSITE to what is meant. (Sarah Cooley , Woods Hole Oeanographic Institution)	Section has been reformulated and this problem has been solved.
207	38524	6	7	33	7	38	This is one of the most important conclusions in the chapter. Make sure it doesn't get lost and consider highlighting it in any summaries (Andrew Pershing, University of Maine)	Thank you, we have made sure that this conclusion is not lost.
208	54392	6	7	33	7	38	It would be useful to explain the high confidence assignment presented here in the corresponding chapter section (6.4.2.1) (Michael Mastrandrea, IPCC WGII TSU)	confidence assignments in the executive summary were checked whether they match the analyses in the text sections and vice versa. A rationale has been given in 6.4.2.
209	52525	6	7	34	0	0	- Bit negative: reducing mortality from other causes will increase resilience to quantitative climate related impacts (e.g. Temperature on sex ratios) but not qualitative ones (loss of beaches). (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Point taken, we now included a phrase on that the reduction in other pressures will enhance resilience to climate change in the text body (6.4.2.)
210	50327	6	7	40	7	40	It potentially seems an overstatement to say "all" on this line--what about some of the land-based CDR techniques, for example? (Katharine Mach, IPCC WGII TSU)	"all" refers to "oceans": "All geoengineering approaches involving manipulation of the ocean..." We removed all because the statement is already comprehensive as such.
211	54391	6	7	40	7	45	It would be useful to explain the high confidence assignment presented here in the corresponding chapter section (6.4.2.2) (Michael Mastrandrea, IPCC WGII TSU)	agreed and adopted in the main text body, 6.4.2.
212	50328	6	7	50	7	51	This described habitable environment presumably is being measured by volume. It may be clearest to indicate this explicitly. (Katharine Mach, IPCC WGII TSU)	agreed and adopted
213	47643	6	7	51	7	52	again, this 'half npp estimate is wrong, and should be more like one quarter if recent ocean estimates of global productivity (36-78 PgC a-1; Carr et al. (2006) and land estiamtes (150–175 PgC a-1; Welp et al., 2011) are to be believed. (John Dunne, NOAA/GFDL)	We have checked and confirmed that the original estimate is still the one agreed on by the community. Here this detail has been lost in the revision exercise.
214	41704	6	7	52	7	52	cyanobacteria is microorganism but not plant. (Rui Zhang, Xiamen University)	This detail has been lost in the revision exercise.
215	48432	6	7	54	7	54	It seems to me that we know a lot about large-scale controls on photosynthesis, respiration and carbon storage. I think classifying these as "poorly known" is an overstatement and risks putting the chapter on unescessarily weak footing. Large uncertainties remain but much is known. (Charles Stock, NOAA/Geophysical Fluid Dynamics Laboratory)	Yes, pooly is not accurate, however, this detail has been lost in the revision exercise.
216	47141	6	7	54	8	1	Revise "...poorly known as most oceanic regions have never been sampled." to "…poorly known, as these processes have never been sampled in most oceanic regions." The subject of the sentence got lost in the first half of the sentence and meaning was not clear. (Sarah Cooley , Woods Hole Oeanographic Institution)	Yes, poorly is not accurate, however, this detail has been lost in the revision exercise.
217	46480	6	8	2	8	3	This acknowledgment of the lack of good time series data was given less weight in Chp 30; I think this chapter is wise to emphasise the point (Neville Smith, Bureau of Meteorology)	Thank you for your strong support. We have added one further reference to this.
218	47644	6	8	3	8	3	remove comma after 'change'. (John Dunne, NOAA/GFDL)	now reformulated requiring a comma
219	38754	6	8	4	0	0	Is another not clear evidence. If trophic cascades occurs in marine waters (and occurs) the amount of nutrient supply plus other environmental aspects (i.e. stratification regime) could promote a top-down control. Not always the mentioned chain of effects could be observed. (Ricardo Anadon, University of Oviedo)	we added that direct effects on organisms and their interactions are also observed.
220	40416	6	8	4	8	6	What about sensitivity to temperature, pH? And the importance of both bottom-up and top-down processes? (Laura Petes, National Oceanic and Atmospheric Administration)	we added that direct effects on organisms and their interactions are also observed.
221	35932	6	8	5	0	0	...controls upper ocean stratification, nutrient supply and ... (changing stratification governs nutrient/light supply as well as heat and oxygen transport into the ocean interior, and CO2 exchange with the atmosphere). (Frank Whitney, Institute of Ocean Sciences)	upper ocean stratification has been added.
222	38525	6	8	8	8	54	The idea of using the LME/biome concept to categorize the impact of climate change is sound; however, this concept is not carreid through in the rest of the chapter. Either keep this thread going or consider dropping it (or scaling back). (Andrew Pershing, University of Maine)	The fate of this figure depends on further coordination with chapter 30. We now mention expansion vs. contraction of biomes in the later text.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
223	47276	6	8	9	8	9	"could be used to track and model the global ocean "I don't think you will find a lot of modellers who think that breaking the global ocean up into subjectively defined units as suggested here is a viable approach. (James Christian, Government of Canada)	The fate of this figure depends on further coordination with chapter 30. We now mention expansion vs. contraction of biomes in the later text.
224	52526	6	8	14	0	0	Community succession does not "optimise" energy transfer and material cycling. Energy transfer and material cycling may be more efficient as succession proceeds. This statement needs references supporting it. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	This detail has been lost in the revision exercise.
225	44192	6	8	19	8	20	Division of the ocean and Figure 6-1 are similar to chapter 30 figure 1, but too complex. It seems no necessary and will be easily confusing in the relationship to Chapter 30, because Chapter 6 is not a regional chapter. (RONGSHUO CAI, Third Institute of Oceanography)	The fate of this figure depends on further coordination with chapter 30. We now mention expansion vs. contraction of biomes in the later text.
226	41705	6	8	19	8	25	Since this chapter treat the ocean as whole and Ch30 have a different system to define subsection of ocean, I suggest to remove this part, as well as Figure 6-1, to avoid confusion. (Rui Zhang, Xiamen University)	The fate of this figure depends on further coordination with chapter 30. We now mention expansion vs. contraction of biomes in the later text.
227	46481	6	8	19	8	35	The beginning of many overlaps with Chp 30. Good approach though. (Neville Smith, Bureau of Meteorology)	The fate of this figure depends on further coordination with chapter 30. We now mention expansion vs. contraction of biomes in the later text.
228	47142	6	8	19	8	35	This paragraph as written provides no insight into why one would want to use ocean regions/biomes and why this idea is being discussed here. Will this idea be used later in the report? It needs context. To improve it, I also suggest inserting "Similarly," at the start of "Benthic habitats...." and adding the following text: "... Chs. 5, 28, and 30). The oceanic and benthic provinces discussed here may provide a more useful basis for comparison of region-specific characteristics than those relating simply to oceanic basins or continents. The present chapter...." and "...human society, so it focuses on global ocean processes rather than those in specific water column or benthic provinces. A broad understanding...." (Sarah Cooley , Woods Hole Oeanographic Institution)	Part of this suggested revision has been adopted: "so it focuses on global ocean processes rather than those in specific water column or benthic provinces "
229	52527	6	8	25	0	0	new paragraph "Benthic habitats have … (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	This detail has been lost in the revision exercise.
230	52528	6	8	28	0	0	Most benthic organisms have wide dispersal in planktonic stages. Need references to support this statement. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	This detail has been lost in the revision exercise.
231	52529	6	8	29	0	0	(should read)... are more limited, even in forms... (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	This detail has been lost in the revision exercise.
232	38632	6	9	3	9	3	Recent review paper may be relevant to this section on recent trends: Sen Gupta A & B McNeil (2012) Variability and change in the ocean. In : The Future of the World's Climate, eds A Henderson-Sellers and K. McGuffie, pp. 141-165, Elsevier, Amsterdam. Also, with respect to observed & projected changes of the tropical Pacific: Ganachaud AS et al (2011) Observed and expected changes to the tropical Pacific Ocean. In Bell JD et al (eds). Vulnerability of tropical Pacific fisheries and aquaculture fo climate change. Secretariat of the Pacific Community, Noumea, New Caledonia, pp 101-187. (Janice Lough, Australian Institute of Marine Science)	This section refers to WGI information and does not yet include information on biological impact.
233	38048	6	9	7	9	7	Ocean primary role is heat storage. - What about water supply? (Ronald Stouffer, Geophysical Fluid Dynamics Laboratory/NOAA)	In terms of biological impact, the change in temperature is crucial not the heat storage.
234	47143	6	9	7	9	7	Strike "related to"... the rest of the paragraph discusses heat storage, not another thing related to heat. (Sarah Cooley , Woods Hole Oeanographic Institution)	In terms of biological impact, the change in temperature is crucial not the heat storage. This detail has therefore been lost in the revision exercise.
235	38049	6	9	9	9	10	Reference for the various warming rates? Uncertainty estimates? (Ronald Stouffer, Geophysical Fluid Dynamics Laboratory/NOAA)	This is very much a WGI question and would have to be handled there as well as conficence levels.
236	41706	6	9	9	9	10	Need a citation for this data. (Rui Zhang, Xiamen University)	citation of WGI, ch 3 has been placed properly now.
237	38755	6	9	11	0	0	In a very recent paper [González-Taboada, F. y Anadón, R. online. Patterns of change in sea surface temperature in the North Atlantic during the last three decades: beyond mean trends. Climatic Change. http://www.springerlink.com/content/n1171w7628217167/?MUD=MP] we show that the lenght of stratification period has increased in the nord Atlantic, but our results shows a high heterogeneity between areas. The question was not only the inensification of thermal estratification if not the differences between areas and the new tempo for spring or summer blooms in each region. IN my opinion there are a great uncertainty on how all these questions impact the phytoplankton and the whole pelagic fod web. I suggest to coment this aspect here or in other parts of the Chapter because probably was one of the main drivers of change for many oceanic areas. (Ricardo Anadon, University of Oviedo)	This is very much a WGI question and would have to be handled there (chs 2,3 and 6,11) as well as confidence levels.
238	35933	6	9	11	9	13	the consequence of warming to most regions of the ocean is increased stratification. However, this is not true in all areas (Southern Ocean, portions of N Pacific; see Ch 30 Fig. 30-3). Increased stratification of the subarctic Pacific relies on a freshening of the surface layer (Durack and Wijffles, 2010; Whitney 2011). (Frank Whitney, Institute of Ocean Sciences)	We now mention that warming and freshening enhance stratification.
239	41707	6	9	13	9	15	Coastal content for Ch5? (Rui Zhang, Xiamen University)	This detail has been lost in the revision exercise.
240	35934	6	9	16	0	0	warming in Okhotsk = 0.68 C over 50 y on the 27.0 isopycnal, with heat being accumulated in this sea being exported to the subarctic Pacific as far downstream as Ocean Station P where waters have warmed 0.018 C/y at 200 m between 1956-2006. refs. Nakanowatari, T., Ohshima, K. I. & Wakatsuchi M. Warming and oxygen decrease of intermediate water in the northwestern North Pacific, originating from the Sea of Okhotsk, 1955–2004. Geophys. Res. Lett. 34, L04602 (2007); Whitney et al (2007). (Frank Whitney, Institute of Ocean Sciences)	This detail has been lost in the revision exercise.
241	47144	6	9	18	9	18	Break into two paragraphs before "The warming trend." (Sarah Cooley , Woods Hole Oeanographic Institution)	This detail has been lost in the revision exercise.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
242	41708	6	9	18	9	25	Why not set a separated "salinity" section? (Rui Zhang, Xiamen University)	This section has been revised and is too short to cut.
243	47145	6	9	18	9	25	So what? This segment about salinity changes does discuss why this matters for circulation reasons, but it would be nice to also include a phrase about why the circulation reasons matter. (Sarah Cooley , Woods Hole Oeanographic Institution)	This detail has been lost in the revision exercise.
244	43009	6	9	21	6	22	"This leads to lower salinity intermediate waters sinking at high latitudes" This is correct but the sentence structure implies the low salinity is the cause of the sinking. Rephrase as :- "This leads to a lower salinity of the intermediate waters that sink at high latitudes..." (Cliff Law, NIWA)	This point has been considered in the revisions.
245	38050	6	9	24	9	24	long-term projections are not available - Why not? Models make these projections?? (Ronald Stouffer, Geophysical Fluid Dynamics Laboratory/NOAA)	This detail has been lost in the revision exercise.
246	47645	6	9	24	9	24	Why are the model sensitivities 'not available'? Starting with Manabe and Stouffer et al., 1993, 1994, long term projections are available, though perhaps not very good. (John Dunne, NOAA/GFDL)	This detail has been lost in the revision exercise.
247	47646	6	9	27	9	27	Not sure what the purpose of the 'therefore' is. (John Dunne, NOAA/GFDL)	This detail has been lost in the revision exercise.
248	48433	6	9	27	9	28	Could you concisely summarize the WG1 consensus on this key point? (Charles Stock, NOAA/Geophysical Fluid Dynamics Laboratory)	We provided a concise summary of the WGI consensus on this key point.
249	38051	6	9	27	9	38	The discussion in this paragraph is unclear. If the climate models' estimates of climate change signal and variance estimates over the past century are accurate, then the estimates quoted here are incorrect. The observational record is too short to accurately estimate the noise (variance). I think one needs to introduce models into this discussion of the observed changes. (Ronald Stouffer, Geophysical Fluid Dynamics Laboratory/NOAA)	We refer to WGI for more detailed information.
250	39362	6	9	27	9	38	This paragraph starts by talking about natural climate variability but ends admitting that there may be anthropogenic influences. Should make it clearer at start that the modes of variability are not possbily totally natural (e.g. Booth Nature 2012) (Gareth S Jones, Met Office)	This detail has been lost in the revision exercise as it relates to WGI efforts.
251	39363	6	9	28	9	31	The Cannaby and Husrevoglu 2009 ref doesn't support this sentence. Half the variance can be explained by the first 3 EOFs, but these are not identical to the NAO, AMO and EA which are only found to correlate with the EOFs. e.g. AMO can explain 34% of the variability of EOF/PC(1). (Gareth S Jones, Met Office)	This detail has been lost in the revision exercise.
252	46482	6	9	42	0	0	These authors use Reynolds whereas Chp 30 used HasISST. Should not matter but to the WG II reader it creates unnecessary clutter. My memory is that the "extension" of reynolds was achieved by developing EOFS from periods with good spatial coverage. This means the frquency bands need to be treated with caution. (Neville Smith, Bureau of Meteorology)	This detail has been lost in the revision exercise.
253	41737	6	9	42	9	42	No reference is made in the text to Fig. 6.2 (Juergen Weichselgartner, University of Kiel)	reference now added to the text
254	46879	6	9	42	9	42	Need to refer to Figure 6-2 within the text. It would be useful to explain in the text what the figure actually means as well as what it is showing. What conclusions can be drawn from the images? (Genevra Harker, HarmonicQuay Ltd)	reference now added to the text. The figure is now better integrated and referred to, for example when emphasizing the relevance of temperature variability to ecosystems
255	52530	6	9	43	0	0	Why just use all data - not just the last 100 years? (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Data covers one century only, this is now clarified in the figure legend
256	46878	6	9	45	9	45	Figure 6-2. Where it refers to the historical maximum and minimum, are these the max and min values within the period 1911 to 2011? The use of the term historical rather than referring to the period confuses this. (Genevra Harker, HarmonicQuay Ltd)	The figure includes only data for the 1911 to 2011 period, and the max and min values refer to this period. We are clarifying this in the legend.
257	38052	6	10	0	0	0	This discussion needs to make it clearer to a reader that the CO2 increase caused by FF burning is the reason for the increasing ocean acidification. This fact can then be promoted to the executive summary where OA is summarized. (Page 5, lines 17-25) (Ronald Stouffer, Geophysical Fluid Dynamics Laboratory/NOAA)	We have emphasized anthropogenic in the revised text and executive summary.
258	46483	6	10	5	0	0	Excellent sub-section (Neville Smith, Bureau of Meteorology)	Thank you for your strong support.
259	41709	6	10	8	10	9	Remove "pH" sentence here since you talk about pH in next paragraph. (Rui Zhang, Xiamen University)	Text has been rearranged accordingly.
260	47146	6	10	11	10	16	The text describing RCP characteristics seems unneccessary and awkward. Can there just be something that refers the reader to a figure plotting these changes? (Sarah Cooley , Woods Hole Oeanographic Institution)	Text has been rearranged accordingly, now starting with atmospheric CO2..
261	47148	6	10	16	10	16	Insert "In all cases, the oceans serve..." (Sarah Cooley , Woods Hole Oeanographic Institution)	This detail is a WGI issue and has been lost in the revision exercise.
262	47147	6	10	17	10	17	Revise to "...thereby reduce global warming somewhat." (Sarah Cooley , Woods Hole Oeanographic Institution)	This detail is a WGI issue and dealt with under services in 6.4. and has been lost in the revision exercise.
263	43010	6	10	18	10	19	A few sentences more are required here detailing the total amount of anthropogenic CO2 taken up by the oceans (Sabine et al, 2004) and its distribution Unless this appears elsewhere..) (Cliff Law, NIWA)	This detail is a WGI issue and dealt with under services in 6.4. and has been lost in the revision exercise.
264	52531	6	10	25	0	0	Say what it has dropped from and over what time scale. Need numbers here. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We have now included the numbers it has started from and define preindustrial here.
265	47149	6	10	27	10	28	Revise to "...concentration and thus also the saturation state." (Sarah Cooley , Woods Hole Oeanographic Institution)	Agreed and adopted
266	47150	6	10	32	10	35	There needs to be some statement of the relevance of all these mineral types and solubilities. Suggest inserting in line 34 between sentences :" In the majority of the contemporary surface ocean, omega-aragonite is greater than 1." Also consider pointing out that these mineral phases appear in biologically generated materials. (Sarah Cooley , Woods Hole Oeanographic Institution)	Agreed and adopted
267	47151	6	10	42	10	42	"the rate of acidification is 50% higher": why? because of circulation, dissolution of CO2, or some other reason? (Sarah Cooley , Woods Hole Oeanographic Institution)	A reason has been included

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
268	47647	6	10	42	10	43	Isn't this simply to point out that the temperature dependency of the Revelle factor gives a higher CO2 absorption and rate of acidification in the subpolar than subtropical regions? Otherwise it sounds a bit more mysterious than necessary. (John Dunne, NOAA/GFDL)	A reason has been included
269	43011	6	10	46	10	48	"In low flow environments…" this sentence seems out of place here in this paragraph. It refers to the small-scale variations in the boundary layers of organisms whereas the rest of the paragraph deals with general large-scale trends in ocean pH (Cliff Law, NIWA)	This detail has been lost in the revision exercise.
270	50329	6	10	50	10	52	It would be helpful to clarify further if these recent observations are thought to be associated with changes in climate or if they are recurring features that have been only recently observed. (Katharine Mach, IPCC WGII TSU)	This detail has been lost in the revision exercise.
271	35935	6	11	0	12	0	The process reducing ventilation of the subarctic Pacific is worth commenting on, for it may foretell broader ocean hypoxia (reduced overturn of the N Atlantic?). Nakanowatari et al 2007 correlate Siberian warming with reduced ice cover in the Okhotsk Sea, thus reducing brine drainage and oxygen transport to the pycnocline waters of the subarctic Pacific. (Frank Whitney, Institute of Ocean Sciences)	This detail has been lost in the revision exercise.
272	47152	6	11	1	11	1	change to "which by deep waters formed"? (Sarah Cooley , Woods Hole Oeanographic Institution)	This detail has been lost in the revision exercise.
273	43012	6	11	5	11	8	The timescale should be defined here - does this refer to OA that has already occurred to the present day, or some future timepoint such as the end of the century? (Cliff Law, NIWA)	Sentence complemented by adding the word anthropogenic.
274	40417	6	11	6	0	0	Change "will" to "would." (Laura Petes, National Oceanic and Atmospheric Administration)	We have retained the wording in concordance with the cited reference.
275	37239	6	11	10	0	0	Fig 6-3 It is almost impossible to see the dark grey and light grey dots that are supposed to represent deep and shallow coral locations. Would it be possible to make the maps bigger and the time series of Co2, and Aragonite saturation at 2 and 25 deg C smaller? (Erica Head, Fisheries and Oceans Canada)	The figure has been lost in the revision exercise and a reference added to WGI chapters 3 and 6.
276	45607	6	11	19	0	0	Chapter 30 and Chapter 6 should use consistent units to describe hypoxic conditions in text and figures (Ch30, p. 11, l. 5 and Ch6, p. 11, l. 19), unless they find a good way to reduce overlap. (Astrid Wittmann, Alfred Wegener Institute for Polar and Marine Research)	Ch30 is well organized to describe regional distribution.
277	35937	6	11	27	0	0	Ongoing climate change is likely to further accelerate the spread of hypoxic zones, especially in temperate/subpolar regions where increases in ocean stratification due to warming or freshening of the surface layer can reduce the depth of winter mixing and the creation of dense waters in association with ice formation. (Frank Whitney, Institute of Ocean Sciences)	This sentence has been modified and added as a nice summary of projected changes.
278	49057	6	11	27	11	28	The sentence could be perceived so that O2 concentration is zero in "permanently anoxic water bodies such as the Black Sea and the Cariaco Basin". I suppose that this applies to the deeper water layers and not the upper layers. Could this be clearified? (Oyvind Christophersen, Climate and Pollution Agency)	we specified that this is the case for 'deep' layers
279	47277	6	11	38	11	38	mixing can also introduce oxygen to subsurface layers (in addition to advection as stated here) (James Christian, Government of Canada)	This detail is a WGI issue and has been lost in the revision exercise.
280	39017	6	11	39	0	41	This sentence presents a definition of "hypoxia" that is radically different from the more conventional definition given in the following paragraph (lines 43-44). I question whether defining hypoxia as oxygen levels "below air saturation" is a good idea. I believe that definitions of hypoxia that reflect biological/ecological issues are preferable to a non-biological definition like "below air saturation." (George Somero , Stanford University)	We have emphasized the traditional definition but it is clear that hypoxia effects set in earlier. This complementary insight has been added and referred to the later introduction of the critical oxygen tension in 6.2.5. where things are discussed in more detail.
281	35936	6	12	0	0	0	Is it worth noting that ocean warming will destabilize large methane deposits which will further tax oxygen supply? Westbrook et al. Escape of methane gas from the seabed along the West Spitsbergen continental margin. GEOPHYSICAL RESEARCH LETTERS, VOL. 36, L15608, doi:10.1029/2009GL039191, 2009 (Frank Whitney, Institute of Ocean Sciences)	This detail is a WGI issue and has been lost in the revision exercise.
282	41738	6	12	1	12	1	The degree of change is represented as a percentage here, which is very useful, but it should be done earlier in the paragraph. (Juergen Weichselgartner, University of Kiel)	This detail is a WGI issue and has been lost in the revision exercise.
283	50330	6	12	14	12	15	For these projections, it would be helpful to specify the relevant climate/socio-economic scenarios and other relevant assumptions. (Katharine Mach, IPCC WGII TSU)	Reference to WGI Figure 6-29 under RCP 8.5 has been added.
284	50331	6	12	21	12	22	For the statement, it could be helpful to comment on potential reporting bias (giving greater attention to dead zones over time) with regard to the measured trends. (Katharine Mach, IPCC WGII TSU)	This potential imbalance has been lost in the revision exercise.
285	52532	6	12	24	0	0	(should read) ...such as the brackish water Aral Sea… (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Agreed and adopted
286	47278	6	12	27	12	27	"Ongoing climate change is likely to further accelerate the spread of hypoxic zones" I would say very likely. (James Christian, Government of Canada)	We have reformulated and now write "very likely"
287	50332	6	12	27	12	29	As possible, the author team should specify the relevant climate/socioeconomic scenarios for the projected increase. (Katharine Mach, IPCC WGII TSU)	This will happen with any future warming and has been formulated that way.
288	47279	6	12	27	12	31	I don't think the 30-70% increase in runoff is a robust projection. Milly et al. 2008 is just a commentary, not primary literature, and shows no values larger than 40%. The two climate modelling papers cited are old (2002). The AR4 WG1 report (section 10.3.2.3) says ">20%" for high latitude land areas under A1B. Their map only shows absolute changes not percentages. Emori and Brown (2005 Geophysical Research Letters doi:10.1029/2005GL023272) show values in excess of 40% but it seems to be in the 10-30 range over the vast majority of the boreal landmass. At the very least, these numbers are scenario-dependent and the scenario should be stated. Also if this is result of climate forcing of the hydrologic cycle it doesn't a priori increase the amount of N or P introduced to the coastal ocean. (James Christian, Government of Canada)	Numbers have been removed as this is a WGI issue not so relevant for hypoxia impact to be discussed in this chapter.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
289	46484	6	12	27	12	41	Yet another excellent review of the literature. Balanced and acknowledging the limits in knowledge and data. (Neville Smith, Bureau of Meteorology)	Thank you for your strong support.
290	52533	6	12	47	0	0	(should read) ....phosphate, silicate, trace elements including iron), vertical.... (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We have reworded the text, comment does not apply any more.
291	47280	6	12	49	12	49	Upwelling should also be mentioned here. I don't think density-driven circulation is a significant factor: it's more about density stratification in relation to wind-driven mixing and upwelling (see also p. 21 lines 26-27). (James Christian, Government of Canada)	Agreed, upwelling is also mentioned and discussed in this context.
292	38756	6	12	50	0	51	In my opinion and with our data the problem of the stratification was not only the shoaling of the UML if not the lenght period of stratification. For instance see [González-Taboada, F. y Anadón, R. online. Patterns of change in sea surface temperature in the North Atlantic during the last three decades: beyond mean trends. Climatic Change. http://www.springerlink.com/content/n1171w7628217167/?MUD=MP], and those changes can modifiy the tempo and intensity of planktonic blooms adn also promote a mismatch between interacting species, and very likely changes in the composition and structure of pelagic (probably also non pelagic in coastal waters) food webs. I suggest to consider this key aspect as potentially important physical driver. (Ricardo Anadon, University of Oviedo)	The duration of stratification is now mentioned, reference has been included. .
293	52534	6	12	51	0	0	(should read) ...surface mixed layer will become shallower in the coming decades... (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	agreed and adopted
294	35938	6	12	52	0	0	it is not necessarily true that nutrient supply will be reduced to a more stratified upper ocean. Whitney 2011 suggest this has not happened in the subarctic Pacific because of increased nutrient accumulation in the ocean pycnocline. This assumption may invalidate many model results in this region. (Frank Whitney, Institute of Ocean Sciences)	agreed and adopted, reference included.
295	37185	6	13	0	0	0	Reference: Jury, M. R. 2011. Long-term variability and trends in the Caribbean Sea. 2011. Int J. Oceanogr. Doi:10-1155/2011/465810 (Erica Head, Fisheries and Oceans Canada)	This detail is a WGI issue and has been lost in the revision exercise.
296	37186	6	13	0	0	0	Reference: Singh, A and T. Delcroix. 2011. Estimating the effects of ENSO upon the observed freshening trends of the western tropical Pacific Ocean. Geophys. Res. Let. 38, L21607, doi:10.1029/2011GL0496361 (Erica Head, Fisheries and Oceans Canada)	This detail is a WGI issue and has been lost in the revision exercise.
297	37187	6	13	0	0	0	One point of interest (to me anyway) is that if salinity is indeed decreasing in these “coral” areas, then it is likely to exacerbate the detrimental effect of increasing atmospheric CO2 levels on coral, since the buffering capacity of seawater is related to salinity. (Erica Head, Fisheries and Oceans Canada)	This detail is a WGI issue and has been lost in the revision exercise. The influence of freshening on acidifcation has been mentioned.
298	38757	6	13	2	0	3	For the same reason that above comment the density stratification could have effects on nutrient diffusivity, but the crucial changes must be related to tempo of stratification. For instance recent expansion of oligotrophic regions northern of subtropical gyres (as in Polovina, Howell and Abecassis, 2008) could be related to expansion of stratification period (Ricardo Anadon, University of Oviedo)	Theformation of stratification is now mentioned, reference has been included. .
299	47281	6	13	2	13	18	I think some discussion of upwelling outside of Eastern Boundary Currents is warranted here. This passage sort of gives the impression that everywhere else mixing dominates vertical nutrient flux, which is not the case (see e.g. Signorini et al 1999 Journal of Geophysical Research 104: 18367). (James Christian, Government of Canada)	agreed and adopted, various sources of mixing and nutrient input dicsussed, reference included.
300	48434	6	13	3	13	3	Capotondi et al., 2012. Enhanced upper ocean stratification with climate change in the CMIP3 models, Journal of Geophysical Research, 117, C04031 23 pp., 2012 provide a comprehensive analysis of stratification changes from AR4 to support this statement. (Charles Stock, NOAA/Geophysical Fluid Dynamics Laboratory)	agreed and adopted, reference included.
301	48435	6	13	3	13	9	Note that increased stratification over ocean basins may also increase the nutrient content of ocean waters upwelled near the coast: Rykaczewski and Dunne (2010). Enhanced nutrient supply to the California Current Ecosystem with global warming and increased stratification in an earth system model. Geophysical Research Letters, 37, L21606, DOI: 10.1029/2010GL045019. (Charles Stock, NOAA/Geophysical Fluid Dynamics Laboratory)	agreed and adopted, reference included.
302	52535	6	13	6	0	0	Need references here. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	reference included according to comment 301
303	47648	6	13	6	13	6	and more importantly, enhanced nutrient content in upwelled waters (Rykaczewski and Dunne 2010 from above) (John Dunne, NOAA/GFDL)	reference included according to comment 301
304	52536	6	13	13	0	14	What was the high food? (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	comment out of place here?!
305	46880	6	13	14	13	18	In Chapter 5, Section 5.2.2.1.6, it states that the theory of intensified upwelling has gained support recently. Need to link these two sections together so there is a clear discussion re upwelling. (Genevra Harker, HarmonicQuay Ltd)	reference to chapter 5 included
306	35939	6	13	16	0	0	Since low and high pressure systems may shift in location, it is equally plausible that upwelling and downwelling centres will move along a coastline, possibly intensifying but not expanding? (Frank Whitney, Institute of Ocean Sciences)	This detail is a WGI issue and has been lost in the revision exercise.
307	46485	6	13	17	13	18	The Chp 30 conclusion was equivocal which I interpreted as low agreement. This turned out to be one of the few instances where Chp 30 was not more bullish. (Neville Smith, Bureau of Meteorology)	Thank you for your strong support.
308	38053	6	13	21	13	39	Relationship of the conclusions to the previous discussion is not clean. Change previous discussion to make conclusions more visible. (Ronald Stouffer, Geophysical Fluid Dynamics Laboratory/NOAA)	The previous text has been checked for balance. The conclusions section has been lost in the revision exercise.
309	48436	6	13	23	13	23	marine ecosystems *will be* exposed - "are" implies that the climate change signal has seperated itself from the variability at regional scales for the environmental drivers mentioned. (Charles Stock, NOAA/Geophysical Fluid Dynamics Laboratory)	The previous text has been checked for balance. The conclusions section has been lost in the revision exercise.
310	46486	6	13	23	13	24	This does not actually say much since they are guaranteed to be exposed. One would need to say eg that the exposure will result in modest/major/significant changes. (Neville Smith, Bureau of Meteorology)	The previous text has been checked for balance. The conclusions section has been lost in the revision exercise.
311	36875	6	13	23	13	39	remove citations from the conclusions section. (all citations are appropriate for the preceding sections but not here) (Antonio Bode, Instituto Espanol de Oceanografia)	The previous text has been checked for balance. The conclusions section has been lost in the revision exercise.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
312	35940	6	13	27	0	0	...due to an excess of respiration over supply (i.e. Open ocean hypoxia is driven by reductions in O2 supply whereas coastal eutrophication results from increased respiration). More generally, hypoxia is not needed for CO2 to accumulate in the interior ocean. Any loss of oxygen accomplishes this at levels well above hypoxia. (Frank Whitney, Institute of Ocean Sciences)	The previous text has been checked for balance. The conclusions section has been lost in the revision exercise.
313	35941	6	13	32	0	0	why the comment "especially during summer"? Winter warming is especially a concern for nutrient supply, whereas summer warming, if excessive, may not reduce primary productivity but just remove it from the view of satellites (subsurface chlorophyll maxima). (Frank Whitney, Institute of Ocean Sciences)	The previous text has been checked for balance. The conclusions section has been lost in the revision exercise.
314	46487	6	13	32	0	0	This seems closer to an established scientific relationship than a finding of this assessment. (Neville Smith, Bureau of Meteorology)	The previous text has been checked for balance. The conclusions section has been lost in the revision exercise.
315	46881	6	13	35	13	36	"Light availability will increase..." - this isn't discussed within section 6.1.1.4 which mentions the shoaling of the mixed layer. Presumably the phytoplankton will be denser within this narrower layer. Is light availability considered a limiting factor at the moment? Please clarify the purpose behind this statement. (Genevra Harker, HarmonicQuay Ltd)	The previous text has been checked for balance. The conclusions section has been lost in the revision exercise.
316	38054	6	13	36	13	36	Add "In high latitudes" before "ice melt". (Ronald Stouffer, Geophysical Fluid Dynamics Laboratory/NOAA)	The previous text has been checked for balance. The conclusions section has been lost in the revision exercise.
317	37184	6	13	38	0	0	“Conversely, enhanced evaporation causes increased salinities at lower latitudes.” This seems to contradict the results shown in Chapter 30, Fig 30-5D, which shows a salinity decrease in the western tropical Pacific over the 1950-2000 period and a (less obvious) decrease in “parts of the Gulf of Mexico”. In Chapter 30 there is no explanation given for these observations (I have suggested there should be). If it helps – these are my comments to the Chapter 6 authors: 1) Jury (2011) shows a decrease in salinity in the Caribbean Sea (and hence perhaps parts of the Gulf of Mexico), which he attributes to changes in circulation, and a greater input of S Atlantic water. 2) Singh and Delcroix (2011) attribute the freshening in the Western tropical Pacific to increased precipitation. (Erica Head, Fisheries and Oceans Canada)	The previous text has been checked for balance. The conclusions section has been lost in the revision exercise.
318	41739	6	13	45	13	47	Sea surface temperature and ocean circulation can also be determined by the fossil record. These were left out of the list. (Juergen Weichselgartner, University of Kiel)	The main direct influences are stated clearly now, temperature, CO2, hypoxia and food, circulation is influencing all of these as a higher order effect, but we aim to concentrate on the direct influences.
319	47282	6	13	51	13	52	"of the last 100 million years (Ma) only the last 2 Myr had atmospheric CO2 at levels lower than any predicted for the next century" The current emission scenarios encompass concentrations up to 1000 ppm: this passage seems to imply that concentrations were higher than this continuously from 100 Ma to 2 Ma. Royer (2006, Geochimica et Cosmoschimica Acta 70: 5665) says pCO2 has been below 500 for most of the last 30-40 Ma (his section 3.6 and Figure 4) and that "CO2 levels today are probably higher than they have been for the last 25 My". (James Christian, Government of Canada)	We have changed the text to CO2 levels comparable to this decade and higher than projections older than 33 Ma to address the ambiguity, given uncertainties in projections and reconstructions.
320	35942	6	13	52	0	0	Ma (Frank Whitney, Institute of Ocean Sciences)	we cannot agree, duration is Myrs, date is Ma
321	47649	6	14	1	14	1	Again the bollide at the K-T boundary and probable supervolcanoes induce faster change, though not associated with elevation of CO2. (John Dunne, NOAA/GFDL)	Large igneous provinces have been associated with fast CO2 but there are no quantifications of inputs yet. The KT is a fair point but again the current estimates do not suggest that the CO2 input (contrary to the reviewers comment) was high enough for a large scale perturbation in the carbon cycle, See Hoenisch et al 2012 for discussion.
322	47283	6	14	2	14	2	"time intervals longer than 10 thousand years (kyr) " I think this is supposed to be 10 million years. (James Christian, Government of Canada)	we do not agree, 10kyrs is meant
323	41740	6	14	38	14	41	The message of this paragraph is not clear. (Juergen Weichselgartner, University of Kiel)	We have deleted the paragraph as the information is redundant with later parts.
324	43013	6	14	38	14	41	This information is repeated on Pg 16 line 1-3 (where it is better placed) (Cliff Law, NIWA)	We have deleted the paragraph as the information is redundant with later parts.
325	41710	6	14	39	14	41	I do not know what is the purpose of this sentence. (Rui Zhang, Xiamen University)	We have edited the text for clarity of its message and deleted the first mention (see comment 324)
326	38055	6	15	4	15	4	2C deep sea warming needs reference. (Ronald Stouffer, Geophysical Fluid Dynamics Laboratory/NOAA)	This detail has been lost in the revision exercise. The reference is: Martin, P. A., D. W. Lea, Y. Rosenthal, N. J. Shackleton, M. Sarnthein, And T. Papenfuss. (2002). Quaternary deep sea temperature histories derived from benthic foraminiferal Mg/C. Earth and Planetary Science Letters 198, 193-209.
327	38056	6	15	5	15	5	no impact on benthic foraminiferal assemblages - needs reference. (Ronald Stouffer, Geophysical Fluid Dynamics Laboratory/NOAA)	This detail has been lost in the revision exercise.
328	47284	6	15	13	15	14	What scenario does this refer to? IPCC does not "predict" emissions or future CO2 concentrations (see also 13/52). (James Christian, Government of Canada)	This wording has been lost in the revision exercise.
329	47285	6	15	15	15	15	"atmospheric CO2 levels between 330-400 µatm" which we have already exceeded (James Christian, Government of Canada)	section has been reworded
330	46488	6	15	17	0	0	Not sure why a confidence level is being attached here. (Neville Smith, Bureau of Meteorology)	because the reconstructions come with some uncertainty which needs to be acknowledged

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
331	40418	6	15	17	6	26	Need to more clearly contrast the past rate with the present rate through wording - e.g. on Line 20, "suggesting that this previous rate and amplitude of change did not pose environmental conditions which could not be adapted to. However, these past enviromnmental changes. . ." (Laura Petes, National Oceanic and Atmospheric Administration)	the statement is exactly in the line below with a direct comparsion
332	52537	6	15	21	0	0	(should read) ... limits which beyond physiological adaptation to environmental change, ... (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	This detail has been reworded.
333	46489	6	15	23	15	24	To this point I have not noted any studies that reveal what the threshold for adaptation to take place. "hence slow enough" suggests there is a known threshold after which adaptation is possible. Later sections do provide more elaboration and perhaps should be forward referenced. (Neville Smith, Bureau of Meteorology)	This detail has been reworded. While there will be a threshold for adapation, as we evidence extinction in the fossil record, the threshold is not known. The absence of extinction though clearly shows that this threshold is not met even without being able to quantify what the threshold is. The lack of knowledge is clearly quantified with limited evidence and low to medium confidence but the general principle is well understood.
334	39364	6	15	24	15	26	"unprececedented rate of change" Is this just for CO2 or is it for temperature/climate also? If the latter what is the evidence for this, I missed it (CO2 concentrations is not evidence for climate change)? (Gareth S Jones, Met Office)	The unprececedented rate of change refers to CO2. This has now been made clear.
335	50335	6	15	25	15	45	For the statements on this page for which summary terms for evidence and levels of confidence are assigned (lines 26, 31-32, and 45), the author team should consider additionally specifying summary terms for agreement per the uncertainties guidance for authors. (Katharine Mach, IPCC WGII TSU)	This detail has been reworded, focusing on evidence and agreement for compositional changes in fauna and flora and on confidence for adaptive capacity.
336	40419	6	15	36	15	42	Need to change the verbage to past tense (instead of present tense). (Laura Petes, National Oceanic and Atmospheric Administration)	Verbage changed to past tense across this section.
337	35943	6	15	50	0	0	Winguth misspelled (Frank Whitney, Institute of Ocean Sciences)	agreed and adopted
338	38526	6	16	1	0	0	I don't know what it means to be a "high food" species (Andrew Pershing, University of Maine)	This detail has been lost in the revision.
339	41711	6	16	1	16	3	Repeating. (Rui Zhang, Xiamen University)	The redundancy has been eliminated.
340	35323	6	16	1	16	5	The Game reference is not specific to Papua New Guinea. I suggest mention of the more critical work involving REDD in PNG by Melick (2010) in Conservation Biology. (Patrick Nunn, University of New England)	Comment not intended for Chapter 6
341	47650	6	16	8	16	8	It is incorrect to say that the models do not show a change in export over the next century. While it is true the models say primary production may go in either direction, the export production is unanimously downward as a function of stratification. Remove the Laws, 2000 reference, and replace with Steinacher et al., 2010). The paleo-analogy is poor since the carbonate cycle was in equilibrium. (John Dunne, NOAA/GFDL)	The paragraph has been removed to avoid confusion
342	35944	6	16	14	0	0	is "a large number of OAEs" an exaggeration? Berner et al 2007 (Oxygen and Evolution. SCIENCE VOL 316 27 APRIL 2007) identify "several" low oxygen events which led to extinctions. Perhaps you are thinking of OAEs on a smaller scale than I am? (Frank Whitney, Institute of Ocean Sciences)	The adjective "large" has been eliminated.
343	40420	6	16	35	0	0	What is a "reef gap?" (Laura Petes, National Oceanic and Atmospheric Administration)	This detail has been reworded.
344	35324	6	16	36	16	37	I have suggested that Chapter 5 uses "salt marsh" and "coastal wetland" interchangeably and, to avoid confusion should just use the latter. (Patrick Nunn, University of New England)	Comment not intended for Chapter 6
345	50336	6	16	44	16	44	For this statement, the author team should additionally consider specifying a summary term for agreement. (Katharine Mach, IPCC WGII TSU)	Evidence and agreement for compositional changes in fauna and flora and on confidence for adaptive capacity have been stated.
346	48437	6	16	49	16	54	These caveats regarding paleo data were not present in the executive summary. (Charles Stock, NOAA/Geophysical Fluid Dynamics Laboratory)	We feel that the paleo-aspects have appropriately been covered in the executive summary and at the beginning of section 6.1.2.
347	37190	6	17	0	0	0	Reference: O'Brien, T. D., P. H. Wiebe and S. Hay (Eds). 2011. ICES Zooplankton Status Report 2008/2009. ICES Cooperatuve Research Report No. 307. 152 pp. (Erica Head, Fisheries and Oceans Canada)	This reference might be more suitable for a regional view in chapter 30.
348	37191	6	17	0	0	0	Reference: Mackas, D.L., W. Greve, M. Edwards, S. Chiba, K. Tadokoro, D. Eloire, M.G. Mazzocchi, S. Batten, A.J. Richardson, C. Johnson, E. Head, A. Conversi and T. Peluso. 2012. Changing zooplankton seasonality in a changing ocean: Comparing time series of zooplankton phenology. Prog. Oceanogr. 97-100, 31-62 (Erica Head, Fisheries and Oceans Canada)	This reference might be more suitable for a regional view in chapter 30.
349	37196	6	17	0	0	0	References: AZOMP. Atlantic Zone Offshore Monitoring Program. Fisheries and Oceans Canada. Description on-line at http://www.bio.gc.ca/science/monitoring-monitorage/azomp-pmzao/azomp-pmzao-eng.php (Erica Head, Fisheries and Oceans Canada)	This reference might be more suitable for a regional view in chapter 30.
350	37197	6	17	0	0	0	GACS. Global Alliance of Continuous Plankton Recorder Surveys. Description on-line at http://www.globalcpr.org/ (Erica Head, Fisheries and Oceans Canada)	This reference might be more suitable for a regional view in chapter 30.
351	38057	6	17	3	19	43	What is punchline of section 6.1.3? Seems like it could be greatly shortened. (Ronald Stouffer, Geophysical Fluid Dynamics Laboratory/NOAA)	We adopted this view and shortened this section discussing the need of sufficiently long-term observation time series.
352	46882	6	17	8	17	8	"(Stommel, 1963; Figure 6-3." Needs a closing bracket after the 3. (Genevra Harker, HarmonicQuay Ltd)	amended during the revision.
353	41741	6	17	8	17	12	Fig. 6.5 largely illustrates non-chemical processes, but the two examples given are chemical in nature. This is a mismatch. (Juergen Weichselgartner, University of Kiel)	This figure cannot capture all details but we shall do our best to revise it accordingly.
354	40421	6	17	9	0	0	Better to use "ecosystem" than "habitat," which is only one component (and service) of an ecosystem. (Laura Petes, National Oceanic and Atmospheric Administration)	habitat replaced by ecosystem

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
355	37240	6	17	14	0	0	Fig. 6 -5 It's not clear where "zooplankton" appear in this diagram about spatial and temporal scales of variability. For example, is "plankton migration" supposed to represent vertical migration by zooplankton? If so, then it does not capture diel migration, because in the spatial scale is too large (I think it should be ~500 m rather than 1000 m) and neither does it capture ontogenetic migration (e.g. by Calanus), because then the time scale is too short (it should be months rather than <1 week). Maybe you need to differentiate the two processes. (Erica Head, Fisheries and Oceans Canada)	This figure cannot capture all details but we shall do our best to revise it accordingly.
356	46490	6	17	14	0	0	This figure is excellent cf counterpart in Chp 30 (Neville Smith, Bureau of Meteorology)	Thank you for your strong support.
357	37195	6	17	18	0	0	Replace next sentence with "New offshore monitoring programs and CPR routes have been initiated since the early 1990s (e.g. Labrador Sea observational program (AZOMP), Pacific and Southern Ocean CPR surveys (GACS)). Additional trends will probably emerge as time series for these and other pre-existing programs continue." (Erica Head, Fisheries and Oceans Canada)	We shortened this whole section discussing the need of sufficiently long-term observation time series moving some detail to table.
358	44193	6	17	23	0	0	Is it necessary for section 6.1.3.1. to introduce so many observation programs in such detail? (RONGSHUO CAI, Third Institute of Oceanography)	We shortened this whole section discussing the need of sufficiently long-term observation time series moving some detail to table.
359	46491	6	17	23	0	0	As pleased as I am to see space devoted to the time series, it is perhaps a luxury in a page constrained world that the authors may not be able to afford. It is background rather than an assessment of the literature so perhaps it could be included as supplementary material if pressure to reduce pages arises (which I suspect it will). (Neville Smith, Bureau of Meteorology)	We shortened this whole section discussing the need of sufficiently long-term observation time series moving some detail to table.
360	36285	6	17	23	19	43	6.1.3.1. The Role of Ocean Time Series observation. Section 6.1.3.2.1. Considering the large contibution of CPR survey to AR5, the section"Continuous Plankton Recorder" seems short compared to other three examples. Also, SAHFOS have been expanding the CPR survey in the North Pacific since 2000, and in Southern Ocean CPR has been conducted in 1990s by Australian Antarctic Division. (Sanae Chiba, JAMSTEC)	We shortened this whole section discussing the need of sufficiently long-term observation time series moving some detail to table.
361	46883	6	17	25	17	25	Spelling: 'benefited'. (Genevra Harker, HarmonicQuay Ltd)	This detail has been lost in the revision.
362	48438	6	17	25	17	38	Some mention of scientific fisheries trawl survey data is likely merited here. These surveys can cover 5 decades or more, often include physical and chemical measurements and continue. A broad overview of these surveys can be found in Stock et al., (2011), On the use of IPCC-class models to assess the impact of climate on living marine resources, Progress in Oceanography, 88(1-4). 1-27. References with further details are included. (Charles Stock, NOAA/Geophysical Fluid Dynamics Laboratory)	We shortened this whole section discussing the need of sufficiently long-term observation time series moving some detail to table.
363	43014	6	17	25	17	48	Although this section is interesting, the historical element should be reduced and replaced with greater emphasis on the value of present-day time series in providing a record of change under contemporary conditions and influences. This then contrasts with the previous Palaerecord section & so emphasises the lack of analogous scenarios for present-day conditions (Cliff Law, NIWA)	We shortened this whole section discussing the need of sufficiently long-term observation time series moving some detail to table.
364	50333	6	17	26	17	26	It may be helpful to clarify if long-term observational data sets are rare--or if even short-term data sets are rare (given the size of the oceans, their depth, etc.). (Katharine Mach, IPCC WGII TSU)	We shortened this whole section discussing the need of sufficiently long-term observation time series moving some detail to table.
365	41742	6	17	28	17	48	The reader is first informed that "most 20th centrury ocean time-series programs have already been terminated (Duarte et al. 1992)" to read in the next paragraph that "In the mid-1980s, in response to a growing awareness of the ocean's role in global climate and potential impacts on marine biological processes, several international scientific programs were established". This is confusing and should be more clearly explained. (Juergen Weichselgartner, University of Kiel)	We shortened this whole section discussing the need of sufficiently long-term observation time series and moving some detail to a table. This introductory text revised accordingly.
366	37189	6	17	33	0	0	"National programs run by marine stations etc." (Erica Head, Fisheries and Oceans Canada)	We shortened this whole section discussing the need of sufficiently long-term observation time series and moving some detail to a table.
367	35945	6	17	33	17	48	Canada still visits Ocean Station P (OSP, 50 N, 145 W) 3 times per year, a program that supports mooring deployments (NOAA) and drifter launches. OSP was a focus of the Canadian JGOFS program. In addition, some of the time-series measurements off the Japanese coast (data archived through Japan Meteorological Agency http://www.jma.go.jp/jma/indexe.html) have been summarized in McKinnell, S.M. and Dagg, M.J. [Eds.] 2010. (Marine Ecosystems of the North Pacific Ocean, 2003-2008. PICES Special Publication 4, 393 p., available on line at www.pices.int), e,g, Oyashio oxygen loss on isopycnal surfaces and a declining trend in surface phosphate were both updated from previous papers. (Frank Whitney, Institute of Ocean Sciences)	We shortened this whole section discussing the need of sufficiently long-term observation time series and moving some detail to a table. This list comprises examples and is not meant to be exhaustive.
368	37192	6	17	36	0	0	I think the description of the CPR survey needs and bit of "expansion". After the above phrase, I would add "CPR sampling is from ships-of-opportunity and by the early 1960s the area surveyed had expanded to include shipping routes across the North Atlantic, between Europe and the coast of North America." (Erica Head, Fisheries and Oceans Canada)	We shortened this whole section discussing the need of sufficiently long-term observation time series and moving some detail to a table.
369	37193	6	17	36	0	0	"Alister Hardy Foundation for Ocean Science (SAHFOS)." (Erica Head, Fisheries and Oceans Canada)	This detail has been lost in the revision.
370	38758	6	17	38	0	0	As many of the time series was referred to northern and oceanic waters, probably was interestintg to incorporate more southern time series. As an example the project RADIALES from the Spanish Institute of Oceanography as successful time-series from 1993 will be interesting. See as reference [Valdés, L. López-Urrutia, A. Cabal, J.A. Álvarez-Osorio, M. Bode, A. Miranda, A. Cabanas, M. Huskin, I. Anadón, R. Alvarez-Marqués, F. Llope, M. Rodríguez, N. 2007. A decade of sampling in the Bay of Biscay: What are the zooplankton time series telling us? Progress in Oceanography, 74: 98-114]. This time series continue until today from 1991, having in some of them more than 20 years. Cover several locations in all coast of Spain (Atlantic and Mediterranean. (Ricardo Anadon, University of Oviedo)	We shortened this whole section discussing the need of sufficiently long-term observation time series and moving some detail to a table.
371	52538	6	17	38	0	0	Some mention of the Plymouth times series would be helpful here. Southward et al. 2005, Advances in Marine Biology. Southward 1980, Nature. Hawkins et al., 2003, Sci. Total. Env. The western channel observatory run by MBA/ PML is an important source of long term data. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We shortened this whole section discussing the need of sufficiently long-term observation time series and moving some detail to a table.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
372	39462	6	17	40	0	0	High precision oxygen measurements also provide important information on marine processes (independent triangulation data) - e.g., Manning et al.'s growing network and CUCUMBER studies. (Sarah Cornell, Stockholm Resilience Centre)	We shortened this whole section discussing the need of sufficiently long-term observation time series and moving some detail to a table. The table solely concentrates on biological data as WGI covers the physical and chemical data.
373	46492	6	17	40	0	0	Great to see the prominence of time-series in this assessment. Some of these sites have delivered sufficient data (> decade) to document variability, but a number had only fleeting lives or were not occupied continuously (eg KERFIX) (Neville Smith, Bureau of Meteorology)	We shortened this whole section discussing the need of sufficiently long-term observation time series and moving some detail to a table.
374	35946	6	17	40	17	48	Newer initiatives like Argo, OceanSITES and Ocean Observatory Initiative might also be mentioned. OceanSITES (http://www.oceansites.org/index.html) especially shows the international effort going into data collection. The intention of each of the >60 sites is to make time-series data broadly available. (Frank Whitney, Institute of Ocean Sciences)	We shortened this whole section discussing the need of sufficiently long-term observation time series and moving some detail to a table. The table solely concentrates on biological data as WGI covers the physical and chemical data.
375	47286	6	17	40	17	48	Line P in the northeast Pacific has also been making high-quality ocean chemistry measurements since the mid 1980s and hydrographic and oxygen for substantially longer (Whitney et al 2007). (James Christian, Government of Canada)	We shortened this whole section discussing the need of sufficiently long-term observation time series and moving some detail to a table. The table solely concentrates on biological data as WGI covers the physical and chemical data.
376	35325	6	17	41	17	44	There is no certainty that coral reefs will grow upwards fast enough to keep pace with future sea-level rise. This specious argument is based on the fact that the measurement of maximum reef upgrowth during postglacial sea-level rise exceeds that at which 21st-century sea level is projected to rise. Why specifically should anyone expect coral reefs today, for hundreds of years ecologically adapted to lateral rather than vertical growth (as during the last deglaciation) and having endured thousands of years of worsening human impacts (unlike the last deglaciation), to behave as did their last deglacial counterparts seems naive. The implication of this paragraph as it stands is that reefs will continue to grow upwards this century at the same pace as sea level rises, which is not what the majority of recent studies have concluded. Perhaps the most comprehensive statement on this topic has been Hoegh-Guldberg's (2011) paper in Regional Environmental Change (already cited) which should be guiding this section in my view. Also Wild et al (2011) in Marine and Freshwater Research. (Patrick Nunn, University of New England)	Comment not intended for Chapter 6
377	37194	6	17	47	0	0	“including ocean acidification (Dore et al. 2009, also WGI report).” (Erica Head, Fisheries and Oceans Canada)	This is exactly what is written in the text. It remains unclear what reviewer refers to. maybe something missing?
378	35326	6	17	47	17	48	This sentence is misleading; it refers only to mega-deltas, not the vast number of smaller ones in which I expect sea-level rise will in fact be the main future driver of (relative) submergence. I am thinking of deltas like the Rewa Delta in Fiji (described in Lata and Nunn, 2011, Climatic Change) although there was no data on subsidence. What I am concerned about is that in focusing on "mega" situations, we are missing large numbers of smaller situations that are collectively as important. (Patrick Nunn, University of New England)	Comment not intended for Chapter 6.
379	37188	6	17	49	0	0	Should something be added here about the ARGO float program and the need to develop biologically-instrumented sensors for use on ARGO floats, gliders and other AUVs in extend monitoring into remote regions and for greater temporal resolution? (Erica Head, Fisheries and Oceans Canada)	We shortened this whole section discussing the need of sufficiently long-term observation time series and moving some detail to a table. The table solely concentrates on biological data as WGI covers the physical and chemical data.
380	44194	6	17	51	0	0	As for section 6.1.3.2., I think it maybe also unnecessary to show these examples. Both section 6.1.3.1 and 6.3.1.2 opcupy too many length. Perhaps readers might mainly focus on what key points the chapter said and it is enough to supply the data or evidence where they come from in the chapter. (RONGSHUO CAI, Third Institute of Oceanography)	We shortened this whole section discussing the need of sufficiently long-term observation time series and moving some detail to a table.
381	46769	6	17	51	19	44	A major part of the text here is used to describe the history of the long-term observation programs. It might be sufficient to mention them in the context of the excellent data sets they are providing or have provided in the past. Or probably use a BOX? (Venugopalan Ittekkot, University of Bremen (retired))	We shortened this whole section discussing the need of sufficiently long-term observation time series and moving some detail to a table.
382	52539	6	17	54	0	0	...and functioning forced by climate (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We shortened this whole section discussing the need of sufficiently long-term observation time series and moving some detail to a table.
383	37199	6	18	0	0	0	Refernece: Barton, A. D., C.H. Greene, B.C. Monger and A.J. Pershing. 2003. The Continuous Plankton Recorder survey and the North Atlantic Oscillation: Interannual- to Multidecadal-scale patterns of phytoplankton variability in the North Atlantic Ocean. Prog. Oceanogr. 58, 337-358 (Erica Head, Fisheries and Oceans Canada)	We shortened this whole section discussing the need of sufficiently long-term observation time series and moving some detail to a table.
384	37200	6	18	0	0	0	Reference: Leterme, S.C., M. Edwards, L. Seurot, M. J. Attrill, P. C. Reid and A. W. G. John. 2005. Decadal basin-scale changes in diatoms, dinoflagellates, and phytoplankton color across the North Atlantic. Limnol. Oceanogr. 50, 1244-1253 (Erica Head, Fisheries and Oceans Canada)	We shortened this whole section discussing the need of sufficiently long-term observation time series and moving some detail to a table.
385	52540	6	18	2	0	0	Perhaps a summary table of listing major long-term data sets would be helpful here? (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Indeed, we followed the reviewers suggestion and changed the section's main content into a table.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
386	36864	6	18	2	18	2	Some examples of long-term coastal programs may be given here (as done for ocean time-series): e.g. Valdés, L., A. Lavín, M.L. Fernández de Puelles, M. Varela, R. Anadón, A. Miranda, J. Camiñas and J. Mas. 2002. Spanish ocean observation system. IEO Core project: Studies on time series of oceanographic data., p. 99-105. In S. Vallerga, N. Pinardi, H.W.A. Behrens, G. Manzella, D. Prandle, D. and J.H. Stel [eds.], Operational oceanography: Implementation at the European and regional scales. Elsevier Science B.V.; Therriault, J.-C., B. Petrie, P. Pepin, J. Gagnon, D. Gregory, J. Helbig, A. Herman, D. Lefaivre, M. Mitchell, B. Pelchat, J. Runge, and D. Sameoto. 1998. Proposal for a northwest Atlantic zonal monitoring program. Can. Tech. Rep. Hydrogr. Ocean Sci. 194: vii+57p. (Antonio Bode, Instituto Espanol de Oceanografia)	We shortened this whole section discussing the need of sufficiently long-term observation time series and moving some detail to a table.
387	52541	6	18	7	0	0	...samples in the North Sea and English Channel .... (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	The sentence was transfered into a table and hence the spelling mistake eliminated.
388	38527	6	18	7	18	13	It's cool to see the CPR featured so prominently in this chapter. While the lines run by SAHFOS in the eastern Atlantic are the longest and have received the most attention, the use of CPRs is much broader. The US National Marine Fisheries Service operates two CPR lines, one in the Gulf of Maine (started in 1961) and another in the Middle Atlantic Bight (started in 1977). There have been several studies describing changes in plankton abundance from these regions: (e. g. Jossi & Goulet 1993, Conversi et al. 2001, Licandro et al. 2001, MERCINA 2001, Pershing et al. 2005, Greene & Pershing 2007, Pershing et al. 2010). I believe that the Canadians are also operating a CPR line in the Northeast Pacific and that the Australians have one in the Southern Ocean. Conversi A, Piontkovski AS, Hameed S (2001) Seasonal and interannual dynamics of Calanus finnmarchicus in the Gulf of Maine (Northeastern US shelf) with reference to the North Atlantic Oscillation. Deep Sea Research II 48:519-520 Greene CH, Pershing AJ (2007) Climate drives sea change. Science 315:1084-1085 Jossi JW, Goulet J (1993) Zooplankton trends: US north-east shelf ecosystem and adjacent regions differ from north-east Atlantic and North Sea. ICES Journal of Marine Science 50:303-313 Licandro P, Conversi A, Ibanez F, Jossi JW (2001) Time series analysis of interrupted long-term data set (1961-1991) of zooplankton abundance in Gulf of Maine (northern Atlantic, USA). Oceanolgoca Acta MERCINA (2001) Oceanographic responses to climate in the Northwest Atlantic. Oceanography 14:76-82 Pershing AJ, Greene CH, Jossi JW, O'Brien L, Brodziak JKT, Bailey. BA (2005) Interdecadal variability in the Gulf of Maine zooplankton community with potential impacts on fish recruitment. ICES Journal of Marine Science 62:1511-1523 Pershing AJ, Head EHJ, Greene CH, Jossi JW (2010) Pattern and scale of variability among Northwest Atlantic Shelf plankton communities. Journal of Plankton Research 32:1675-1684 (Andrew Pershing, University of Maine)	We shortened this whole section discussing the need of sufficiently long-term observation time series and moving some detail to a table. This list comprises examples and is not meant to be exhaustive.
389	47287	6	18	7	18	13	There is also a CPR program in the Pacific since at least 2000 (e.g., Batten, SD, and AW Walne, 2011. Variability in northwards extension of warm water copepods in the NE Pacific. Journal of Plankton Research 33: 1643-1653) (James Christian, Government of Canada)	We shortened this whole section discussing the need of sufficiently long-term observation time series and moving some detail to a table.
390	36502	6	18	8	0	0	I do not think this was the purpose of the CPR program – we would never have got the funding for it if it had been! (Keith Brander, DTU)	The sentence was rephrased and transfered into a table.
391	52542	6	18	8	0	0	More should be made of the CPR work, including its coverage and use of ships of opportunity. This is a little brief and does not highlight the importance of CPR. Understanding recruitment processes in fisheries related studies was also an important reason for this work. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We shortened this whole section discussing the need of sufficiently long-term observation time series and moving some detail to a table.
392	37198	6	18	9	0	0	I think there should be something about CPR observations across the entire North Atlantic Ocean here, rather than just reference being made to the North Sea (hardly an oceanic site). My suggestion: "changes that might be attributable to climate (Reid et al., 2003)." Add here:"CPR sampling has, for example, demonstrated a positive long-term trend in phytoplankton levels across the North Atlantic between 1948 and 2000, which is thought to be related to climate forcing (Barton et al., 2003; Leterme et al., 2005)." Then return to the original text :"One of the most important etc" (Erica Head, Fisheries and Oceans Canada)	The entire content was significantly shortened and the information moved to a table.
393	36501	6	18	10	0	0	I do not think the hypothesis stated here is as important result of the CPR program to date. (Keith Brander, DTU)	We shortened this whole section discussing the need of sufficiently long-term observation time series and moving some detail to a table.
394	47288	6	18	25	18	25	I don't see how the sampling design could have "missed" the 1976 regime shift in the way it could miss e.g., the peak of the 1982-83 El Nino. In 1976-77 the state of the ecosystem would have fundamentally changed and even if there is a sampling gap this would have been detectable. (James Christian, Government of Canada)	We shortened this whole section discussing the need of sufficiently long-term observation time series and moving some detail to a table.
395	35947	6	18	44	0	0	Recent results from CalCOFI show how fish communities respond to hypoxia (Koslow, J.A., Goericke, R., Lara-Lopez, A. & Watson, W. Impact of declining intermediate-water oxygen on deepwater fishes in the California Current. Mar. Ecol. Prog. Ser. 436, 207-218 (2011). McClatchie, S et al. Oxygen in the Southern California Bight: Multidecadal trends and implications for demersal fisheries. GEOPHYSICAL RESEARCH LETTERS, VOL. 37, L19602, doi:10.1029/2010GL044497, 2010) (Frank Whitney, Institute of Ocean Sciences)	These references are mentioned in the relevant hypoxia section.
396	37201	6	18	47	0	0	Section 6.1.3.2.3. The North Pacific Subtropical Gyre - Were there no observations of zooplankton abundance/community structure from the same cruises/programs that provided the observations of phytoplankton biomass? (Erica Head, Fisheries and Oceans Canada)	We shortened this whole section discussing the need of sufficiently long-term observation time series and moving some detail to a table. Sure there were zooplankton data collected but the table is listing only selected findings.
397	38528	6	18	47	0	0	NPSG is a region, not a sampling program. I would call this HOTS: Hawaiin Ocean Time Series and note that the JGOFS established HOTS at this location based on prior work. (Andrew Pershing, University of Maine)	We shortened this whole section discussing the need of sufficiently long-term observation time series and moving some detail to a table.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
398	52543	6	18	53	0	0	(should read) ...between zooplankton (weeks) and .... (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We shortened this whole section discussing the need of sufficiently long-term observation time series and moving some detail to a table.
399	48439	6	19	27	19	43	Note that Henson et al., 2010; Detection of anthropogenic climate change in satellite records of ocean chlorophyll and productivity, Biogeosciences, 7 (2) DOI: 10.5194/bg-7-621-2010 suggests that the SeaWiFS time series is too short in most places to detect climate change trends in chlorophyll relative to those driven by climate variability (Charles Stock, NOAA/Geophysical Fluid Dynamics Laboratory)	We shortened this whole section discussing the need of sufficiently long-term observation time series and moving some detail to a table. This reference has been included.
400	38759	6	19	28	0	0	I suggest to introduce as satellites the actual MODIS-MERIS and AQUARIUS because were the instruments for now and for the future. (Ricardo Anadon, University of Oviedo)	We shortened this whole section discussing the need of sufficiently long-term observation time series and moving some detail to a table.
401	47289	6	19	30	19	30	No. Ocean colour sensors sample to one optical depth everywhere. It's around 25 m in the clearest waters; in more turbid waters it's less but it's still one optical depth (1/k). (James Christian, Government of Canada)	We shortened this whole section discussing the need of sufficiently long-term observation time series and moving some detail to a table.
402	47118	6	19	34	19	35	The most recent analyses of ocean color NPP models at various marine regions worldwide is (Saba, V.S., Friedrichs, M.A.M., Antoine, D., Armstrong, R.A., Asanuma, I., Aumont, O., Behrenfeld, M.J., Ciotti, A.M., Dowell, M., Hoepffner, N., Hyde, K.J.W., Ishizaka, J., Kameda, T., Marra, J., Mélin, F., Moore, J.K., Morel, A., O'Reilly, J., Scardi, M., Smith Jr., W.O., Smyth, T.J., Tang, S., Uitz, J., Waters, K., Westberry, T.K. 2011. An evaluation of ocean color model estimates of marine primary productivity in coastal and pelagic regions across the globe. Biogeosciences, 8, 489-503) (Vincent Saba, NOAA National Marine Fisheries Service)	We shortened this whole section discussing the need of sufficiently long-term observation time series and moving some detail to a table.
403	47119	6	19	35	19	36	Add the word "estimated" before primary production. (Vincent Saba, NOAA National Marine Fisheries Service)	We shortened this whole section discussing the need of sufficiently long-term observation time series and moving some detail to a table.
404	47290	6	19	35	19	43	Behrenfeld et al 2006 attempted to show a global relationship between productivity and stratification, but in practice it's almost purely driven by ENSO. That there is a strong ENSO effect on primary productivity in the tropical Pacific had been shown previously e.g. by McClain et al (2002, Deep-Sea es. II 49: 2533) who also showed that this effect is robust to the assumptions the productivity algorithms make about temperature dependence. (see also below section 6.3.1) (James Christian, Government of Canada)	We shortened this whole section discussing the need of sufficiently long-term observation time series and moving some detail to a table.
405	41712	6	19	46	0	0	Section 6.2. I like to see this section as the 1st part of this chapter. (Rui Zhang, Xiamen University)	We feel that the "point of departure" section, i.e., the brief description of recent, paleo- and historical trends, should be presented first
406	46770	6	19	46	47	5	These pages cover section 6.2. Subsections here sound like " detailed primers" on topics such as ocean acidification and hypoxia as well as marine microbes. These are also topics which reappear in Chapters 3 and 30. Again, the use of boxes and cross referencing might be useful alternatives for presentation. (Venugopalan Ittekkot, University of Bremen (retired))	We implemented some cross-references between chapters, however, the principles of climate change effects are not addressed or not in similar ways in the other chapters
407	46493	6	19	48	0	0	Once more, a wonderful overview of the science (with also a little assessment) but it may be a luxurious investment of space. (Neville Smith, Bureau of Meteorology)	Thank you for your strong support. We agree and have shortened the subsection.
408	46494	6	20	1	0	0	"these observations"? The above is based on models. Perhaps An assessment such studies and associated projections … (Neville Smith, Bureau of Meteorology)	agreed and modified
409	44195	6	20	7	20	15	Schoolbook? (RONGSHUO CAI, Third Institute of Oceanography)	Given that this report is intended for general readers rather than scientists, we believe that this introductory paragraph is useful
410	35948	6	20	7	20	51	If the audience for this report is intended to be broad, the discussion of adaptability in the sea is probably too detailed. (Frank Whitney, Institute of Ocean Sciences)	Given that this reoprt is intended for general readers rather than scientists, we believe that this introductory paragraph is useful but we have shortened substantially.
411	41713	6	20	10	0	0	You should spell out from what angle that "most eukarya are also single-celled…", e.g. abundance? Diversity? Biomass? (Rui Zhang, Xiamen University)	This detail has been lost in the revision.
412	41747	6	20	13	20	22	Insurance can also prevent that individual homeowners adapt to extreme events because the risks are transferred. Since on a societal level risk spreading (better: risk transfer) does not reduce aggregate risks, other aspects - not mentioned in the paragraph - are important, e.g., solidartity and incentives. For instance, the Elbe River floods 2002 in Germany were considered a case for national solidarity rather than of individual responsibility and, therefore, the Federal Government, the federal states and the European Union were instantly willing to fund an unprecedented portion of the damages. The floods also revealed that insured persons had taken better precautionary measures than uninsured persons and, similarly, implemented emergency measures. This contradicts the widespread notion that an insured person is not interested in reducing damage. Full reference: Mechler, R. & Weichselgartner, J. (2003): Loss financing in the case of the Elbe River floods 2002. Interim Report IR-03-021, International Institute for Applied Systems Analysis (IIASA), Laxenburg. (Juergen Weichselgartner, University of Kiel)	Comment not intended for Chapter 6 (Chapter 16!)
413	41743	6	20	15	20	16	The use of the term "focuses" should be consistent (on page 23, line 42, the - to my understanding - correct term "foci" is used) (Juergen Weichselgartner, University of Kiel)	This detail has been lost in the revision.
414	44196	6	20	22	20	33	Schoolbook? Do readers need these definations to understand the chapter. (RONGSHUO CAI, Third Institute of Oceanography)	See reply to comment 410

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
415	39018	6	20	25	0	0	The logic here is questionable. How does the distinction between autotroph and heterotroph "lead to" categorizations of the type given? Notably, "bacteria" can be autotrophic or heterotrophic. Archaea are not included at all. I think rewriting this sentence is in order. (George Somero , Stanford University)	This detail has been lost in the revision.
416	38760	6	20	25	0	26	I suggest to eliminate zooplankton from this list. All others cited groups represent taxonomic entities and invertebrates also incorporate more of the zooplankters. Also I suggest to change the term phytoplankton for a more general of algae/plants to homogenise the terms. (Ricardo Anadon, University of Oviedo)	This detail has been lost in the revision.
417	38529	6	20	28	20	33	This seems unnecessary to me. After all, I don't recall seeing "photolithoautotroph" or "chemoorganoheterotroph" used in subsequent sections. (Andrew Pershing, University of Maine)	This detail has been lost in the revision.
418	47153	6	20	35	20	35	Revise table 1 to a concept map or multiple-choice pathway graphic? The 2nd and 3rd columns are entirely repetitive… (Sarah Cooley , Woods Hole Oeanographic Institution)	This table has been revised.
419	41744	6	20	36	20	40	The term "mixothroph" is introduced in the footnote, but neither used in the table (6.1), nor in the entire chapter 6. (Juergen Weichselgartner, University of Kiel)	The term mixotroph is mentioned here just for completeness in the metabolic states of the sea.
420	44197	6	20	42	20	43	Bookstyle, but some contents such as 'the standing stock DNA sequence variation', 'reversible histone modifications and DNA methylation' etc. are not easily to understand for ordinary readers. (RONGSHUO CAI, Third Institute of Oceanography)	This detail has been lost from the revised text.
421	39019	6	20	42	21	2	The discussion of genetic variation is clumsy and misleading. "Local adaptation" has a very specific meaning, one that differs from the implied use of the expression made here. After being told that variation is maintained at "high levels," the next sentence states that this issue is "currently unresolved." The shift to a focus on epigenetic mechanisms is questionable, especially because the final sentence states that there are no data on this mechanism of adaptation in marine species. There is a wealth of information on genetic variation in marine organisms and how this variation plays into processes of adaptation to environmental change. This is an important topic that receives to little treatment here. This paragraph needs re-thinking and re-writing. (George Somero , Stanford University)	This text section has been shortened and clarified during the revision.
422	47291	6	21	0	0	0	Section 6.2.1.2 A paper that questions the whole Margalef paradigm is Ruiz et al 2004 PNAS 101: 17720. This paper sort of smacks you across the forehead and makes you say "that's so obvious! why didn't I think of it?" (James Christian, Government of Canada)	As emphasized in the text, Magalef concept offers no quantitative predictions. However, we do believe that it is generally consistent with observations. We dropped the Mandala figure though, for other reasons.
423	52544	6	21	1	0	0	(should read) ...and mammals (decades). The role of epigenetic phenomena in marine organisms and the consequences for ecosystems is currently unexplored. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	This detail has been lost from the revised text.
424	38530	6	21	4	21	5	In the first sentence, you establish the idea of ontogenetic diet shifts. You then suggest that this leads to "stabilizing structure known as a food web." First, you don't need ontogenetic diet shifts to get a food web, you just need predators and prey. Second, the existence of a foodweb doesn't imply stability--some foodwebs are stable, others are not. I think this would also hold for foodwebs with ontogenetic diet shifting. (Andrew Pershing, University of Maine)	This detail has been lost from the revised text.
425	40422	6	21	4	21	5	Need a better description of food web - food webs can also consist of adults eating each other, so the definition implied by food webs consisting of juveniles and adults isn't quite right. (Laura Petes, National Oceanic and Atmospheric Administration)	The text has been revised to make things clearer.
426	52545	6	21	7	0	0	...will cascade upwards through the .... (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	agreed and modified
427	52546	6	21	7	0	0	Perhaps introduce bottom-up and top-down concepts here. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	The intended length of text does not allow expansion here.
428	52547	6	21	8	0	0	ADD: This is known as bottom up forcing. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	This detail has been lost from the revised text.
429	38058	6	21	8	21	9	if decreases rates .... Occur - Due to what? Expand to explain reasoning here. (Ronald Stouffer, Geophysical Fluid Dynamics Laboratory/NOAA)	This detail has been lost from the revised text.
430	48440	6	21	8	21	10	Note that primary production is a very poor predictor of fisheries yields at a global scale (Friedland et al., 2012. Pathways between primary production and fisheries yields in large marine ecosystems, PLoS-ONE, 7 (1); see also the Ryther, 1969 therein). The relationship between primary production and fisheries yields is complex and changes in the structure of the planktonic foodweb can strongly modulate the relationship between NPP and fisheries production. (Charles Stock, NOAA/Geophysical Fluid Dynamics Laboratory)	We added "..The export of energy from pelagic food webs contributes critically to defining the patterns of fishery yields (Friedland et al., 2012)." to the pelagic section.
431	38761	6	21	9	0	0	This phrase is a bit confusing, Why? Because could reasonable that poor pelagic ecosystem (oligotrophic) has less NPP but in a opposite way the transfer of energy and matter could be very efficient, with many trophic levels. For this reason they can transmit to bigger heterotrophs a small amount of energy and matter, and not only as less prodcutive. Probably is interesting to note this aspect as. ....production occurs, instead their high efficience of transfer of energy and materials through the food web, supplied a samll amount of biomass to higher trophic levels. (Ricardo Anadon, University of Oviedo)	The text has been revised to make things clearer.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
432	38762	6	21	16	0	17	I suggest to change the term reduced for upwellings for the term changed. The reason will be that changes in seasonallity (tempo) instead to increased intensity could affect to the whole ecosystem and transform it. As and example of changes in season with biological implications I suggest the paper of [ALISON C . ILES, TARIK C. GOUHIER, BRUCE A. MENGE, JULIA S . STEWART, ALISON J . HAUPT and MARGARET C. LYNCH. 2012. Climate-driven trends and ecological implications of event-scale upwelling in the California Current System. Global Change Biology (2012) 18, 783–796, doi: 10.1111/j.1365-2486.2011.02567.x]. Another interesting aspect could be the reducing trends at some regional scales (there are several evidencias of seosonal change and a decreasing trend in summer in the seasonal Northwest Iberian Peninsula upwelling) instead the global trend represent a rising trend. This mode of change also affect pelagic as well as coastal ecosystem with economic implications aquaculture and others (I reflect this implications in specific points). As convincing evidences I suggest 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; F I Z F. PÉ REZ*, XOSE A . PADÍN, YOLANDA PAZOS, MIGUEL GILCOTO, MANUEL CABANAS, PAULA C. PARDO, Maria DOLORES DOVALand LUIS FARINA-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 (Ricardo Anadon, University of Oviedo)	The text has been revised to make things clearer, however, we cannot expand on these aspects too much.
433	47120	6	21	16	21	18	But see (Rykaczewski, R. R. & Dunne, J. P. Enhanced nutrient supply to the California current ecosystem with global warming and increased stratification in an earth system model. Geophys. Res. Lett. 37, L21606 (2010)) where the GFDL ESM2.1 showed increased NPP with decreased upwelling in the California Current Ecosystem. (Vincent Saba, NOAA National Marine Fisheries Service)	We have fomulated this as a conditional sentence as clear projections of future trends are not available.
434	35949	6	21	17	0	0	What leads you to speculate on a strong reduction in upwelling? Locally, upwelling regions could weaken, intensify or shift depending on changes in wind fields. Perhaps generalize this to say "if upwelling were modified ...resulting in changes in fish production" (Frank Whitney, Institute of Ocean Sciences)	We have fomulated this as a conditional sentence as clear projections of future trends are not available.
435	38531	6	21	17	0	0	This is a good example of my general comments about overuse of the IPCC style. This is a speculative statement: if upwelling is reduced, then fish would decrease. I don't think you need the "High confidence" especially when there is low confidence that this would happen (if anything, your predictions are for increased upwelling). Save the confidence statements for specific climate predictions. (Andrew Pershing, University of Maine)	Confidence statement has been removed here.
436	35950	6	21	25	0	0	"temperature- or salinity-dependent stability" In the subarctic Pacific, salinity controls winter stratification. (Frank Whitney, Institute of Ocean Sciences)	This detail is agreed upon but has been lost from this revised text.
437	52548	6	21	25	0	0	(shoud read) ...phosphate, silicate, iron, and other trace elements), influenced … (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	The text has been revised accordingly.
438	35951	6	21	26	0	0	"In the open ocean, the upward flux..." also by ocean circulation which creates upwelling (subploar) and downwelling (subtropical) gyres. Coastal oceans are nutrient enriched by several other processes (tidal mixing, estuarine circulation, upwelling) (Frank Whitney, Institute of Ocean Sciences)	The text has been revised accordingly.
439	47121	6	21	30	21	30	But there may be also changes in the nutrient concentrations of deeper waters due to circulation changes. Again see (Rykaczewski, R. R. & Dunne, J. P. Enhanced nutrient supply to the California current ecosystem with global warming and increased stratification in an earth system model. Geophys. Res. Lett. 37, L21606 (2010)) (Vincent Saba, NOAA National Marine Fisheries Service)	The reference has been added.
440	43018	6	21	42	21	42	Table 6.2 Productivity should be "Low" in low-latitude gyres, and moderate-high in the Southern Ocean (Cliff Law, NIWA)	agreed and adopted in Table 6.2. We used to think production was less than 150 mg C/m2/d and now we know that with new methods it is 3-4 fold higher. It is within 2-3x of the highest coastal regions which run about 1-2 g C/m2/day. If you want to move back to low-medium or even low I think most would agree. The more interesting thing, to me, is that the production is higher than the biomass would predict which means that gyres have some of the highest production per unit biomass of anywhere in the sea. This is likely a result of cell size, and specific growth rates, but we should not get into all this in our chapter.
441	41745	6	21	52	21	54	Figure 6.6 does not show the interactions between the ocean and atmosphere (bidirectional) on radiation. Aerosols affect light levels in the ocean (which are depicted) and the aerosol loading in the atmosphere (especially the marine boundary layer) is strongly influenced by the ocean and phytoplankton (e.g. Leck et al., 2005). (Juergen Weichselgartner, University of Kiel)	This figure has been dropped.
442	48275	6	22	0	0	0	Benthic habitats and Ecosystems: This is too detailed for a general scientific audience to understand or absorb (Malini Nair, Indian Institute of Science)	With the revision and shortening that has happened the level of detalization in this section seems to be reasonable and consistent with that in the other sections of 6.2.1.
443	38532	6	22	9	0	0	You mention turbulence, but the figure is labled "mixing." Please be consistent. Also, while turbulence is necessary for mixing, they have different effects on phytoplankton. Mixing dilutes the mixed layer but usually adds nutrients. Turbulence, even without mixing, can have an effect on nutrient uptake rates, predator-prey relationships, and sinking rates. (Andrew Pershing, University of Maine)	We agree. The term "turbulence" in this sentence should be replaced by "mixing". However, this detail has been lost during the revision.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
444	52549	6	22	9	0	0	Will more acidic conditions favour diatoms? (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Effects of ocean acidification are discussed in detail in Section 6.2.2. and 6.3.4. We are aware that diatoms rather than dinflagellates may benefit from warming (6.3.2.) but cannot make a statement on acidification.
445	43016	6	22	24	22	28	It should be also be noted that organisms in the intertidal zone have greater tolerance of extremes than subtidal/pelagic organisms (Cliff Law, NIWA)	This point has been included in the revised text.
446	43015	6	22	28	22	30	Many benthic species in intertidal zones have pelagic larval stages, which permits escape from this area. Climate change effects will be gradual/chronic over periods of years, as opposed to acute effects from which sessile organisms cannot escape. (Cliff Law, NIWA)	This point has been included in the revised text.
447	48441	6	23	13	23	23	There is a need to reconcile these statements with the executive summary (p. 3, line 22-23). The "very high confidence" in the ES seems at odds with these more measured statements. (Charles Stock, NOAA/Geophysical Fluid Dynamics Laboratory)	We disagree. The ES claims that there is a very high confidence that marine organisms do react on climate change - and this is indeed so. The statement in section 6.2.2 cited by the reviewer, however, refers to attribution of the reaction to specific factors, which is much less certain. Therefore, there is no contradiction between the two statements.
448	39020	6	23	17	0	18	This statement on limited OA information seems to fly in the face of the information presented in two recent papers by Kroeker et al., which are given in the references. These studies, one of which is a meta-analysis of existing OA effects (Ecol. Lett. Paper), show that, in fact, quite a bit of information is available here. An 'in press' paper by Kroeker et al. in Nature Climate Change takes a detailed look at ecosystem structural changes under OA (using the Ischia carbon dioxide vents as study system). I note that on page 26 this topic is examined in more detail and the misleading statement on limited information is rectified. Note that Kroeker is misspelled in line 28 on page 26. (George Somero , Stanford University)	We insist that the effects of the ongoing acidification on ecosystems are generally less well understood than those of temperature and hypoxia (even with the recent findings by Kroeker et al). The meta-analyses largely refer to laboratory studies. Attribution of field phenomena to ongoing anthropogenic ocean acidification is only possible for a few species.
449	40423	6	23	20	0	0	Should change to "field and laboratory experiments need" (Laura Petes, National Oceanic and Atmospheric Administration)	This detail has been lost from the revised text.
450	52550	6	23	34	0	0	Rephrase this paragraph. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	This text section has been shortened and clarified during the revision.
451	40424	6	23	37	0	0	Is this supposed to say "the microscopic" (not the "macroscopic")? (Laura Petes, National Oceanic and Atmospheric Administration)	This detail has been lost from the revised text.
452	41714	6	23	46	0	0	Section 6.2.2.1.1. Compared to following sections, it is too short. I expect some info about animals (e.g. Fishes) in this section. (Rui Zhang, Xiamen University)	We clarified that the term heterotrophs and foraging species comprises the animals.
453	37202	6	23	48	0	0	I thought this first paragraph was a bit lacking in substance and clarity. E.g. what is meant by “current regime”? Does the “current regime” include eddies, extents and positions of gyre, strengthening (or weakening) of the Gulf Stream etc.? Is it referring to the fact that in some regions the currents will assist some planktonic organisms to move to higher latitudes (i.e. to escape the heat), while doing the reverse in other regions? I don’t know what to suggest, because I don’t know what they are trying to say. When I read “current regime” initially I though they were referring to “present conditions”. And, the paragraph gets even vaguer when it comes to heterotrophs. At the moment this paragraph is a waste of space. (Erica Head, Fisheries and Oceans Canada)	We have replaced "Current regime" with "circulation regime at different spatial scales" for clarity. Otherwise we insist that the statements are summarizng the relevant principles here.
454	47651	6	23	48	23	48	Add comma after ‘phototrophs’ (John Dunne, NOAA/GFDL)	Sentence structure has changed with the revision.
455	35953	6	23	50	0	0	Has NPP been defined previously? (Frank Whitney, Institute of Ocean Sciences)	NPP has been defined on first mention
456	43017	6	23	50	23	50	a citation for iron? (Cliff Law, NIWA)	We have added a citation for iron: Pitchford, J.W. and Brindley, J. (1999) Iron limitation, grazing pressure and oceanic high-nutrient-low chlorophyll (HNLC) regions. Journal of Plankton Research, 21(3), 525-547.
457	47292	6	23	50	23	50	"control on NPP by mean underwater light levels (Sverdrup, 1953) or iron" and macronutrients (James Christian, Government of Canada)	This information has now been added.
458	47652	6	23	54	23	54	Add comma after ‘heterotrophs’ (John Dunne, NOAA/GFDL)	comma added
459	38763	6	24	1	0	4	Until the supply of energy is a key aspect for heterotrophs (like the available nutrients and their cycling are for phytoplankton and seaweeds), there are other influential mechanism to define the distribution of species in the ocean (as well in terrestrial and continental aquatic environments), the interactions between species, predator-prey, compiting or simbiotic species, or others indirect interactions. I suggest to consider this very general consideration when transmit to o not specialist people the ideas about the meaning about the availability of food. In resume, is important but there are another aspects related with the influence of climate change on species. Probably this comment will be more general and I suggest to be considered when explain the metabolic limits related with warming , acidification or others. I very recent reference could be [Sunday, J.M. Bates, A.E. Dulvy, N.K. 2012. Thermal tolerance and the global redistribution of animals. Nature Climate Change, doi:10.1038/nclimate1539: 1-5] (Ricardo Anadon, University of Oviedo)	This is correct, we are addressing common principles here. We now refer to the predator-prey relations and other factors mentioned by the reviewer 2hich are addressed later in the chapter. The reference is included in 6.2.5.
460	35250	6	24	42	0	0	Insert 'algae and 'before 'plants' (Christian Wiencke, Alfred Wegener Institute)	agreed and modified
461	52551	6	25	1	0	0	Perhaps say where these species live in very extreme vent environments in many cases? (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	The legend of figure 6-8 has been complemented by mentioning habitats as suitable.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
462	38533	6	25	20	0	0	More water breathing. (Andrew Pershing, University of Maine)	We now say "animals breathing in water".
463	40425	6	25	20	0	0	Change "water breathing" to a better descriptor. (Laura Petes, National Oceanic and Atmospheric Administration)	We now say "animals breathing in water".
464	52552	6	25	47	0	0	The importance of recruitment fluctuation (reproductive success, larval output, early juvenile survival) in driving biological interactions could be emphasized. Most evidence comes from intertidal studies (see Helmuth et al, 2006 AREES for review; Polocanska et al, 2008 Ecology, but these processes are likely to apply in pelagic and offshore benthic systems as well. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	This is a valid point, we now add: ", also via shifts in reproductive success, larval output, early juvenile survival and thus recruitment."
465	40426	6	25	51	25	52	Yes they have - for example, with Pisaster (sea stars) and Mytilus (mussels) on the U.S. West Coast - see Sanford 1999, Pincebourde et al. , etc. (Laura Petes, National Oceanic and Atmospheric Administration)	We cannot draw too much on intertdal examples as these are to be addressed in Chapter 5.
466	38764	6	26	12	0	0	Probably the driving responses to temperature were not only linked to the global trend, if not also on seasonality of stratification, changes in the UML depth. In general changes in temperature a different temporal scales will be disentagled to properly understand their impacts. In my opinion, some results in the literature reflect the idea, the changes of temperature at local scales were the cause of observed changes, but few efforts has been done to summarise this cain of knowledge and priorizing global knowledge, producing a less precise picture or the driviong mechanisms. (Ricardo Anadon, University of Oviedo)	We can agree with these statements, but, probably, no changes in the text are required. Temporal temperature variability has been addressed in Figure 6-2.
467	35954	6	26	19	0	0	...ocean acidificiation (OA)... (Frank Whitney, Institute of Ocean Sciences)	agreed and modified
468	40427	6	26	28	0	0	Should be Kroeker (not Koeker), right? (Laura Petes, National Oceanic and Atmospheric Administration)	agreed and modified
469	39463	6	26	30	0	0	water breathing' is defined here, but has been used several times in the chapter already - it can be a confusing term so the definition needs to appear at first use. (Sarah Cornell, Stockholm Resilience Centre)	We agree. Animals breathing in water have been given on first use of the term.
470	52553	6	26	30	0	0	This definition should be earlier. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We agree. Animals breathing in water have been given on first use of the term.
471	47154	6	26	30	26	51	Should there be some discussion in this paragraph about the biomineralization process? (Sarah Cooley , Woods Hole Oeanographic Institution)	Some discussion about the biomineralization process(calcification) has been included.
472	35955	6	26	43	0	0	pHi - define (Frank Whitney, Institute of Ocean Sciences)	pHi is intracellular pH but this detail has been lost from the revised text.
473	47155	6	27	1	27	1	What are the meaning of the blue/red and dashed/solid "exchange proteins" in the figure? It's not clear from the caption. (Sarah Cooley , Woods Hole Oeanographic Institution)	The figure has been simplified and explained more thoroughly.
474	35327	6	27	40	28	21	The emphasis of this section on planned, formal responses ignores the informal adaptation of urban and peri-urban dwellers to climate change. I am thinking especially of housing built on stilt houses out across water areas, which is a tradition thousands of years in duration in the Asia Pacific. It has been described in the context of future adaptation from Tonle Sap in Cambodia (Nuorteva et al, 2010, Journal of Water and Climate Change) and from Korail in Dhaka (Bangladesh) by Jabeen et al (2010, Environment and Urbanisation). (Patrick Nunn, University of New England)	Comment not intended for Chapter 6
475	35956	6	28	0	0	0	Perhaps worth mentioning: low frequency sound transmission increases with OA. This can make oceans noisier for marine mammals, potentially disrupting their communications (Hester et al., 2008. Unanticipated consequences of ocean acidification: A noisier ocean at lower pH. GEOPHYSICAL RESEARCH LETTERS, VOL. 35, L19601, doi:10.1029/2008GL034913) (Frank Whitney, Institute of Ocean Sciences)	While this mechanism has been theoretically discussed, there is no evidence of its actual impact on marine ecosystems. This has been mentioned in 6.2.5..
476	35957	6	28	1	0	0	parameters (Frank Whitney, Institute of Ocean Sciences)	Thanks for spotting this. This detail has been lost from the revised text.
477	39464	6	28	1	0	0	processes and Parameters' - correct the typo, but also explain what these parameters actually are for - they are only parameters in the context of modelling and quantitative representation of system relationships. Something needs to be said earlier on in the chapter about the role of modelling and how the observational evidence discussed in these earlier sections has informed marine biogeochemical/ecosystem model design and development (some text on this appears on page 29, but it is very cursory, given the critical role of modelling in predicting climate impacts on marine environment) (Sarah Cornell, Stockholm Resilience Centre)	It has been mentioned that some of this understanding has informed modelling activities.
478	37203	6	28	13	0	0	“Principle hypoxia effects” should be “Principles of hypoxia effects” (Erica Head, Fisheries and Oceans Canada)	agreed and modified
479	39021	6	28	15	28	29	The definition of "hypoxia" is again an issue. See my comment on the comparable section on page 11. To term waters where the oxygen concentration is below what would be found at full air saturation as "hypoxic" is not a good way to define "hypoxia" from the standpoint of physiology. (George Somero , Stanford University)	Yes, this definition is physical to begin with, but it is often used in the literature. See reply to comment 280. These subtleties have traditionally been ignored in biochemistry more than physiology but have ecological relevance as mild hypoxia can constrain animal life.
480	38765	6	28	40	0	0	With the same general feeling that the previous comment, the OCLTT concept is a very interesting aspect that could explain some of the impacts of climate change on especies distribution and abundance, and obviously at geological or evolutive scales. But in any case there are others, probably we call ecological interactions, that could explain a great part of the observed changes at local or regional scales. Between this last causes the was dependent of interactions between species and those relationships could be mediated by environmental changes, tempo and intensity of them, most related with larvae or microscopic stages survival. In my opinion this cain of effects was not considered in many studies and cause a great uncertainty in projections for future changes. In my opinion some of these ideas should be introduced to modulate the message of the report. (Ricardo Anadon, University of Oviedo)	The point here is to emphasize the need to develop an understanding across levels of biological organiszation and to report and assess ourrespective knowledge. The link to species interactions and recruitment has now been emphasized.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
481	38534	6	28	45	28	46	Again, I don't think that using the IPCC "High confidence" is necessary here. (Andrew Pershing, University of Maine)	We have now largely confined the use of uncertainty language to the conclusion sections.
482	41746	6	28	50	28	50	The word "constrains" conveys the wrong meaning. OA actually exacerbates the temperature related problems. (Juergen Weichselgartner, University of Kiel)	OA does exacerbate temperature-related problems by constraining the thermal windows, so we consider the statement made in the text to be correct.
483	38766	6	28	54	0	0	Change Philipaert by the correct Philippart (Ricardo Anadon, University of Oviedo)	Correct use of this name has been ensured throughout the text.
484	50334	6	29	20	29	27	For the statements in this paragraph, the author team should consider additionally specifying summary terms for agreement per the uncertainties guidance for authors. (Katharine Mach, IPCC WGII TSU)	Where we felt it being appropriate we have specified summary terms for agreement.
485	41715	6	29	30	0	0	Section 6.2.2.2. I am very happy to see this "microbial" section. (Rui Zhang, Xiamen University)	Thank you for your strong support.
486	35958	6	29	32	29	33	"..responsible for most nutrient cycling and underpin net ecosystem productivity..." nutrient cycling also depends on grazers since they may excrete ammonium for use by phyto. Also, net community production includes energy transfer to higher trophic levels such that the presence (or lack due to eg fishing) of predators also has control on ecosystem productivity. (Frank Whitney, Institute of Ocean Sciences)	The text has been revised to make things clearer and focus on aspects relevant for microbes.
487	41716	6	29	48	0	0	Seciton 6.2.2.2.1. When talking about temperature, bacteria in polar ecosystem should be mentioned. E.g. Kirchman DL, Moran XAG, Ducklow H. 2009. Microbial growth in the polar oceans—role of temperature and potential impact of climate change. Nature Review Microbiology. 7:451-459. (Rui Zhang, Xiamen University)	This reference has been included as it provides a wider than polar overview.
488	48442	6	29	48	29	48	Discussion of Eppley (1972) Temperature and phytoplankton growth in the sea, Fisheries Bulletin, 4 1063-1085 and the follow up study by Bissinger and colleagues (Bissinger et al., 2008. Predicting marine phytoplankton maximum growth rates from temperature: Improving on the Eppley curve using quartile regression. Limnol. Oceanogr. 487-493 seems warranted here. (Charles Stock, NOAA/Geophysical Fluid Dynamics Laboratory)	This reference has been included as it provides an update to the Eppley curve.
489	47653	6	29	52	29	52	The concept that microbes are going to reach an upward thermal limit seems intensely speculative. I would think this shouldn't happen until at least 33C and perhaps 35-37C if it is the enzymatic limits controling this. (John Dunne, NOAA/GFDL)	We do not claim that all microbes are going to reach their thermal limit, but species replacements occur across temperatures. We hypothesize that warming may affect their organismal performance.
490	36286	6	29	53	0	0	What is the "whole organism tolerances" ? (Sanae Chiba, JAMSTEC)	The word "whole" has been removed.
491	38767	6	29	53	0	0	Instead setting perfortmances I suggest change to: stting performances or competitive adventage. The reasons are well explained by my previous comments (Ricardo Anadon, University of Oviedo)	"competetive advantages" has been added here
492	38768	6	30	15	0	0	Change Sarmento by the correct Sarmiento (Ricardo Anadon, University of Oviedo)	This suggestion is in error, the first author is Sarmento, H.
493	37204	6	30	25	0	0	"Ocean time-series data, such as the Continuous Plankton Recorder survey reveal little change in the seasonal timing (phenology) of the diatom spring bloom, which may depend more on changing light levels." This is not correct as written. In the NW Atlantic (Scotian Shelf) CPR sampling showed a switch to earlier blooms of diatoms during the 1990s. So, I would replace the above sentence and the next one with: (Erica Head, Fisheries and Oceans Canada)	This detail has been lost from the revised text.
494	37205	6	30	25	0	0	"Ocean time-series data, such as the Continuous Plankton Recorder survey, reveal little change in the seasonal timing (phenology) of the diatom spring bloom that can be attributed to changes in temperatures directly, although earlier emergences of dinoflagellates during the growth season may be the result of them responding to warming in the North Sea (Edwards and Richardson, 2004, Figure 6-7 C, 6.3.2.)." (Erica Head, Fisheries and Oceans Canada)	This detail has been lost from the revised text.
495	38769	6	30	27	0	28	In a recent paper we study the treends in temperature but also the timing and lenght of the stratification period for whole north Atlantic Basin and adyacent Seas. Is not possible to analise the results about changes in species abundance but in any case the observed changes could be associated to stratification in two ways. First by responding to the warming trend itshelf; Second, responding with biological responses, i.e. deepening their distribution. Due to the methodology of the CPR have difficulty responding appropriately. (Ricardo Anadon, University of Oviedo)	This may be correct, but we do not think that any ammendments of the text are needed
496	37206	6	30	29	0	0	I thought there should be something here about the likely effect of temperature on the size structure of the phytoplankton community, e.g. as demonstrated by Moran et al. 2010, that phytoplankton at higher temperatures have higher proportions of smaller cells. (Erica Head, Fisheries and Oceans Canada)	This statement and reference have been included.
497	37207	6	30	29	0	0	Reference: Moran, X.A.G., A. Lopez-Urrutia, A. Calvo-Diaz and W.K.W. Li. 2010. Increasing importance of small phytoplankton in a warmer ocean. Global Change Biology. 16, 1137-1144 (Erica Head, Fisheries and Oceans Canada)	This statement and reference have been included.
498	38535	6	30	33	0	0	Medium confidence that things will change? Again, I think this is an abuse of the IPCC style. (Andrew Pershing, University of Maine)	We have now largely confined the use of uncertainty language to the conclusion sections.
499	47293	6	30	33	30	33	"medium confidence" I would say high. (James Christian, Government of Canada)	We have now largely confined the use of uncertainty language to the conclusion sections.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
500	38770	6	30	38	0	40	In a very recent paper Arrigo et al., observed a extraordinary phytoplankton bloom below sea ice in the Arctic [Arrigo, K.R. Donald K. Perovich, Robert S. Pickart, Zachary W. Brown, Gert L. van Dijken, Kate E. Lowry, Matthew M. Mills, Molly A. Palmer, William M. Balch, Frank Bahr, Nicholas R. Bates, Claudia Benitez-Nelson, Bruce Bowler, Emily Brownlee, Jens K. Ehn, Karen E. Frey, Rebecca Garley, Samuel R. Laney, Laura Lubelczyk, Jeremy Mathis, Atsushi Matsuoka, B. Greg Mitchell, G. W. K. Moore, Eva Ortega-Retuerta, Sharmila Pal, Chris M. Polashenski, Rick A. Reynolds, Brian Schieber, Heidi M. Sosik, Michael Stephens, and James H. Swift. 2012. Massive Phytoplankton Blooms Under Arctic Sea Ice. Science, 336: 1408]. For this reason the potential effect of irradiance on blooms in the polar environments must be explained with more caution. (Ricardo Anadon, University of Oviedo)	We include this reference to provide a more comprehensive picture of what favors Arctic phytoplankton blooms.
501	35959	6	30	46	0	0	comment: not all krill (euphausiids) feed on ice algae, e.g. the substantial communities in the N Pacific (Frank Whitney, Institute of Ocean Sciences)	we now say "some" krill
502	36867	6	31	1	31	28	In this section, evidences and references from the productive continental shelves are generally outweighed by those from the larger oligotrophic areas of the ocean, where most of the production and chlorophyll is well below the surface layer, and does not include cyanobacteria and other small phytoplankton. The specific analysis of continental shelf ecosystems, including field data in the most productive upwelling areas (e.g. Chavez et al., 2011), revealed a large variety of trends at scales of several decades but a general increase of phytoplankton carbon fixation by phytoplankton in most shelves (Sherman and Hempel, 2009; Chavez et al., 2011; Bode et al., 2011). In the coastal studies, however, it is generally acknowledged that the increases may have been caused both by climate changes (both natural and anthropogenic) and by direct anthropogenic effects (e.g. artificial fertilizers release). At least a mention to this issue should be incorporated in this section. Additional references: Bode, A., J. Hare, W. K. W. Li, X. A. G. Morán, and L. Valdés, 2011: Chlorophyll and primary production in the North Atlantic. ICES Status Report on Climate Change in the North Atlantic., P. C. Reid and L. Valdés, Eds., International Council for the Exploration of the Sea, 77-102. Sherman, K. and G. Hempel, 2009: The UNEP Large Marine Ecosystem Report: A perspective on changing conditions in LMEs of the world's Regional Seas. Vol. 182, UNEP Regional Seas Reports and Studies, United Nations Environmental Programme, 872 pp. (Antonio Bode, Instituto Espanol de Oceanografia)	This statement and additional references have been incorporated into the text.
503	35960	6	31	3	0	0	a confusing sentence (Frank Whitney, Institute of Ocean Sciences)	We agree, we re-phrased the text
504	48443	6	31	3	31	7	Note that there are three rebuttals to the Boyce paper cited here, two of which raise significant questions about systematic biases in the manner in which in-situ chlorophyll and secchi depth measurements were blended for the analysis that may contribute to the trends discuss here. Referencing these rebuttals seems warranted. (Charles Stock, NOAA/Geophysical Fluid Dynamics Laboratory)	This is absolutely right. We have included these citations of the rebuttals and commented on them accordingly.
505	47122	6	31	4	31	7	The Boyce et al. 2010 paper has received a large amount of criticism from the biological oceanographic community. The journal Nature has published three separate rebuttals to this paper, all of which provide robust data and analyses to completely disregard the conclusions of Boyce et al. 2010. The citations for the three rebuttals are: A. McQuatters-Gollop et al. Nature 472, 10.1038/nature09950 (2011); D. L. Mackas Nature 472, 10.1038/nature09951 (2011); R. R. Rykaczewski & J. P. Dunne Nature 472, 10.1038/nature09952 (2011). I strongly suggest including the rebuttals as citations within this IPCC report if the authors go forward with citing and discussing the results of Boyce et al. 2010. (Vincent Saba, NOAA National Marine Fisheries Service)	This is absolutely right. We have included these citations of the rebuttals and commented on them accordingly.
506	47654	6	31	4	31	10	While the interannual variability described in the Boyce et al (2010) analysis was ground-breaking, the long term conclusions of the Boyce et al. 2010 study were fundamentally flawed and have been repeatedly debunked (See three rebuttals in Nature). Please remove the statements and reference. Go to original references on CPR and CalCOFI studies (i.e. Askes and Ohlman secchi depths) for robust analyses of the long term trends. (John Dunne, NOAA/GFDL)	This is absolutely right. We have included these citations of the rebuttals and commented on them accordingly.
507	46495	6	31	7	31	11	This seems to be a slightly different interpretation cf with Chp 30. They reported high confidence in the expansion of the core areas, which I interpreted to mean as identified from ocean color data. (Neville Smith, Bureau of Meteorology)	The confidence level has been balanced with chapter 30.
508	38771	6	31	8	0	9	The limited evidences reflected in these lines due to uncertainties in the interpretation of chlorophyll measurements fro satellites, represent a big mistake for the whole chapter because many of the references about changes in NPP are related to models that use the saellite data. Is obvious that uncertainties exist in used algorithms, but is our best source of data for the whole ocean. Obviously with problem. In my opinion another key cause of uncertainty is related with the methodology used to calibrate the above emntioned algorithms, the Primary Production data based on 14Carbon, Oxygen and other methodologies. There are abundant literature about the problem of lack of blancs in all these measurements, and the decrease of PP estimations when 14 carbon was incorporated as usual methodology, and most in oligotrophic waters. I suggest in any case introduce a complementary comment at this respect (Ricardo Anadon, University of Oviedo)	This is exactly what was stated in the previous text and is now mentioned also in 6.1.3. "...It has been reported with limited evidence and low agreement, due to uncertainties in the interpretation of chorophyll measurements from satellite". The text has now been balanced more accordingly.
509	35961	6	31	11	0	0	a qualifier is needed for all satellite trends - they tell us nothing about the variability in subsurface chlorophyll. Enhanced stratification may result in the enhancement of primary productivity at the nutricline. Also, trends based on <20 y of observations do not resolve impacts of bidecadal variation such as the Pacific Decadal Oscillation or the lunar nodal cycle (e.g. Watanabe et al GEOPHYSICAL RESEARCH LETTERS, VOL. 35, L01602, doi:10.1029/2007GL032188, 2008). (Frank Whitney, Institute of Ocean Sciences)	This statement and additional reference have been incorporated into the text.
510	47655	6	31	11	31	11	This type of speculation of a climate change driver in these has been subsequently debunked and re-attributed to the fact that the SeaWiFS record began with the Nino of the century (Henson et al., 2010) who included a rigorous detection and attribution component. (John Dunne, NOAA/GFDL)	This statement and additional reference have been incorporated into the text.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
511	48444	6	31	11	31	11	Henson et al., 2010l; Detection of anthropogenic climate change in satellite records of ocean chlorophyll and productivity, Biogeosciences 7 (2) suggests that such changes cannot be reliably attributed to climate change. (Charles Stock, NOAA/Geophysical Fluid Dynamics Laboratory)	This statement and additional reference have been incorporated into the text.
512	36865	6	31	13	31	22	Besides estimations of primary production based on chlorophyll (and the associated errors mentioned in this paragraph) direct measurements of inorganic carbon fixation also point to the variability of trends at local and regional scales (see review of long time series in Chavez et al., 2011). This must be mentioned in this section as now it only referes to chlorophyll estimates and gives the impression that these estimates are variable and uncertain because of the assumptions in the converion from chlorophyll to carbon fixation. The citation Chavez et al. (2011) is listed in the reference list. (Antonio Bode, Instituto Espanol de Oceanografia)	The following sentence: "The long in situ time series also point on variability of trends at the global and regional scales (Chavez et al., 2011)" has been added to the end of this paragraph.
513	36866	6	31	23	31	28	This section only presents nutient inputs from deep waters. Fixation of atmospheric N in the tropical and subtropical occeans, however, will likely gain more importance in warmer and stratified oceans (e.g. Sohm et al., 2011). Recent field studies point also to a growing fraction of primary production derived from atmospheric N in large ocean basins (e.g. Mouriño-Carballido et al., 2011). Additional references: Mouriño-Carballido, B., R. Graña, A. Fernández, A. Bode, M. Varela, J. F. Domínguez, J. Escánez, D. De Armas, and E. Marañón, 2011: Importance of N2 fixation vs. nitrate eddy diffusion along a latitudinal transect in the Atlantic Ocean. Limnol. Oceanogr., 56, 999-1007. Sohm, J. A., E. A. Webb, and D. G. Capone, 2011: Emerging patterns of marine nitrogen fixation. Nat. Rev. Microbiol., 9, 499-508. (Antonio Bode, Instituto Espanol de Oceanografia)	These points and references suggested by the reviewer have now been added.
514	38772	6	31	24	0	0	In a recent paper we have demonstrated the long term change on nutrient concentration and the influence of winter preformed waters on phytoplankton communities. As this type of changes probably were more frequent in a warmed future their effects on phytoplankton will permeate in the same direction [Llope, M., Anadón, R., Sostres, J.A.,Viesca, L. (2007) Nutrients dynamics in the southern Bay of Biscay (1993-2003): winter supply, stoichiometry, long-term trends and their effects on the phytoplankton community. J.Geophys.Res. doi:10.1029/2006JC003575]. Some of the observed expansion of subtropical low chlorophyll areas (see Polovina et al, 2008) couldbe associated to this very important aspect, and I suggest to introduce as o short comment. (Ricardo Anadon, University of Oviedo)	This suggestion is appreciated but the message is not clearly conveyed in whether this is a generla principle. It has not caused us to change the text.
515	37208	6	31	31	0	0	Section 6.2.2.2.4. Ocean acidification – effects of anthropogenic CO2 concentrations and water pH Somewhere in this section, and I'm not quite sure where, there should be a mention of the effects of acidification on "modern" foraminifera. For example, Moy et al. (2009) have suggested that the pelagic foraminiferon, Globigerina bulloides, now has a thinner shell than it did in the Holocene. In addition, Dias et al. (2010) report that the community composition of the benthic foraminifera in the naturally low pH waters off the island of Ischia in the Mediterranean is significantly different from those in nearby, unaffected waters. I know these studies are mentioned later, but everything else is getting repeated at some stage, so why not this? (Erica Head, Fisheries and Oceans Canada)	This point has been included in the revised text but not here and we have cut back on redundancies in the revision.
516	37242	6	31	31	0	0	The previous comment on this section should have had these References Dias, B.B., M.B. Hart, C.W. Smart and J.M. Hall-Spencer. 2010. Modern seawater acidification: the response of foraminifera to high-CO2 conditions in the Mediterranean Sea. Journal of the Geological Society, London. 167, 843-846 Moy, A.D., W.R. Howard, S.G. Bray and T.W. Trull. 2009. Reduced calcification in modern Southern Ocean planktonic foraminifera. Nature Geoscience. 2, 276-280 (Erica Head, Fisheries and Oceans Canada)	This point has been included in the revised text but not here and we have cut back on redundancies in the revision.
517	41717	6	31	31	0	0	Section 6.2.2.2.4. Although very limited, I think you should include those studies on OA effects on Prochlorococcus and Synechococcus, major contributors for PP. And, this one:Beman JM et al., 2011, PNAS 108, 208-213. (Rui Zhang, Xiamen University)	This point has been included in the revised text. The Beman paper has been discussed in the context of field observations under 6.3.
518	37209	6	31	33	0	0	Should "algae" be replaced by "phytoplankton" (for clarity)? (Erica Head, Fisheries and Oceans Canada)	This detail has been lost from the revised text.
519	46496	6	31	33	31	52	Much more circumspect cf Chp 30 (Neville Smith, Bureau of Meteorology)	These uncertainty levels have to be discussed with ch.30 team.
520	52554	6	32	14	0	0	(should read) ...largely relegated found in stratified, eutrophic … (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	we replaced relegate with found in...
521	43019	6	32	31	32	34	A recent publication on natural mixed microbial communities in surface South Pacific waters found no effect of increased CO2 on one of the dominant nitrogen-fixing groups, the unicellular cyanobacteria A group (which are not currently available in laboratory cultures). This was attributed to physiological differences from the filamentous nitrogen-fixers or potential control by iron availability, and emphasises different responses within groups that occupy the same functional niche. (Law C.S., Breitbarth E., Hoffmann L.J., McGraw C.M., Langlois R.J., LaRoche 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. doi: 10.1111/j.1365-2486.2012.02777.x) (Cliff Law, NIWA)	Thank you for the information, but probably no amendments to the text are needed. This is one reason we have low confidence in impacts of CO2/OA on N fixation.
522	35962	6	32	51	0	0	the consumption of organic C (not the flux) must exceed the supply of oxygen. High flux commonly leads to carbon burial. (Frank Whitney, Institute of Ocean Sciences)	We agree. The sentence has been re-phrased as "Wherever the consumpton of organic matter supporting bacterial metabolism …"
523	35963	6	32	53	0	0	include also the age of water (time since in contact with atmosphere). (Frank Whitney, Institute of Ocean Sciences)	This is already meant by "restricted water movement", isn't it?
524	47294	6	32	54	32	54	"bacteria both create and sustain OMZs" and Archaea? (James Christian, Government of Canada)	This sentence, indeed, should be re-phrased as "bacteria create OMZs and sustain them …" THE POINT IS WHETHER ARCHAE CONTRIBUTE????
525	43020	6	33	0	33	0	It should be noted that the amount of N2O production during both denitrification and nitrification increases significantly under low oxygen (1-10 uM) (Cliff Law, NIWA)	This detail has been lost from the revised text.
526	38773	6	33	17	0	0	Change Bengula by Benguela (Ricardo Anadon, University of Oviedo)	This detail has been lost from the revised text.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
527	35964	6	33	31	33	34	Deutsch is referring to the tropical and subtropical Pacific. In the subarctic Pacific, tidal mixing creates a bidecadal oscillation in oxygen supply from the Okhotsk Sea into the interior ocean (Nakanowatari et al. 2007; Keeling et al 2010 and references therein). Oxygen declines result from reductions in ice formation, a trend which should continue unabated based on warming projections. (Frank Whitney, Institute of Ocean Sciences)	Correct, but this effect is regional, while we are talking about general mechanisms here. We do not think any amendment to the text is needed here.
528	46497	6	33	37	0	0	Very sound (Neville Smith, Bureau of Meteorology)	Thank you for your strong support.
529	47295	6	33	44	33	47	I can't really tell what this means. I seems to be saying that we can robustly infer the microbial response to biological processes like primary production or calcification but we can't robustly infer the response of these to climate. On the whole I find this sentence quite vague and difficult to interpret. (James Christian, Government of Canada)	This sentence emphasizes the response of microorganism species. This has now been complemented.
530	50337	6	33	44	33	47	For this statement, the author team should additionally consider specifying a summary term for agreement, or perhaps the level of confidence without the summary term for evidence. (Katharine Mach, IPCC WGII TSU)	OK. "Robust evidence" is removed
531	41718	6	33	50	0	0	Section 6.2.2.3. Please make sure that this section is not covered in Ch5. (Rui Zhang, Xiamen University)	As explicitly mentioned in the beginning of this subsection, this topic is also addressed in Ch.5. However, here we present a somewhat different angle of view, and the material in the two chapters complement each other rather than overlap
532	46771	6	33	50	5	5	Chapter 3 also discusses this topic under "submerged vegetation", Cross referencing useful. (Venugopalan Ittekkot, University of Bremen (retired))	agreed and modified
533	49058	6	33	53	33	54	"Although marine macrophytes cover only 0.6 % of the area of the world's oceans (Smith, 1981) their production amounts to almost 10 % of total oceanic production" Could you clearify whether this comprises also the production in coastal waters, and closed-in seas like the Black sea and Baltic sea? (Oyvind Christophersen, Climate and Pollution Agency)	Yes it does, this has been added.
534	38774	6	34	6	0	0	The effect between temperature change (warming) and seaweeds or kelps abundance probably is nor related only to the response to growth, but alsdo with reproductive performance or others biological responses. At this respect I suggest as reference the impresive book of [Luhning K (1990) Seaweeds, their environment, biogeography and ecophysiology. John Wiley & Sons, London]. For a more concrete long term response I suggest to incorporate the long term response of a kelp to warming referred in the paper [C. Fernández (2011): The retreat of large brown seaweeds on the north coast of Spain: the case of Saccorhiza polyschides , European Journal of Phycology, 46:4, 352-360]. In a long term survey this author shows a decreasing trend until disappearance of a kelp specie related with climate change: warmer summer temperatures, also related with decreased upwelling events during summer. (Ricardo Anadon, University of Oviedo)	We now say: Their growth-response curves reflect specialization of production on the local temperature regime. This includes reproduction and other performances. This is also a Chapter 5 issues and we cannot expand too much on this. The field study has now been mentioned in 6.3.
535	40428	6	34	12	34	13	This is the temperature limit for ALL algae, or one type from one location? Needs clarification. (Laura Petes, National Oceanic and Atmospheric Administration)	This detail has been lost from the revised text.
536	35328	6	34	19	34	45	In this section there should be explicit mention of corruption as an institutional barrier, particularly in poorer countries of the region. A good reference is West, 2011, Law, Environment and Development Journal. (Patrick Nunn, University of New England)	Comment not intended for Chapter 6.
537	37210	6	34	37	0	0	Should “algae” be replaced by “macroalgae” (for clarity)? (Erica Head, Fisheries and Oceans Canada)	agreed and modified
538	37211	6	34	41	0	0	Should “algae” be replaced by “macroalgae” (for clarity)? (Erica Head, Fisheries and Oceans Canada)	agreed and modified
539	46498	6	35	2	35	5	The conclusions here appear to have a very sound basis. (Neville Smith, Bureau of Meteorology)	Thank you for your strong support.
540	50338	6	35	4	35	5	For clarity of communication in this conclusion, it would be preferable to avoid the pairing of "medium confidence" and "may." (Katharine Mach, IPCC WGII TSU)	The pairing of "medium confidence" and "may" has been removed.
541	40429	6	35	20	0	0	Please change "water breathing" and "air breathing" to something more informative. (Laura Petes, National Oceanic and Atmospheric Administration)	The term "water breathing" has been explained earlier in the chapter. It makes a big difference whether an organism breathes in water or in air. This distinction is explained in the appropriate places.
542	38775	6	35	28	0	0	I suggest to introduce in extremes the idea of periods or events. For instance the number of days above a certain value temperature in a specif period, as reflect the paper of Fernandez on Saccorhiza (see previous comment). The idea is to avoid miss interpretations for non specialist readers. Also is interesting some results about diferential distributional changes of warmer and cooler origen species; see for instance [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] (Ricardo Anadon, University of Oviedo)	This is also a Chapter 5 issues and we cannot expand too much on this, especially not on regional issues beyong genral principles.
543	52555	6	35	36	0	0	...mortality including new recruits (Polocanska et al, 2008 Ecology) or behaviour... (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	This detail is agreed upon but has not been included in the text as it is not relevant for the principal message. An example is given in Table 6-6
544	38776	6	35	36	0	39	The paper of [Sunday, J.M. Bates, A.E. Dulvy, N.K. 2012. Thermal tolerance and the global redistribution of animals. Nature Climate Change, doi:10.1038/nclimate1539: 1-5] is relevant to this aspect, and I suggest to consider. Also in my opinion is pertinent to comment the interactions between growth and predation in both pelagic and clearly in benthic environments. (Ricardo Anadon, University of Oviedo)	The paper by Sunday et al has been included as a reference for marine animals exploiting the width of their thermal niche.
545	52556	6	35	48	0	0	(should read) ...marine species are more eurythermal.... (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	agreed and modified

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
546	38777	6	36	1	0	2	At this respect I suggest to introduce also the outbreaks of some very special organisms, jellyfish, that could interact with eggs and larvae of many pelagic organisms included fishes, exploited and non exploited. As reference I suggest the long-term study in the North Atlantic [P. Licandro, D. V. P. Conway, M. N. Daly Yahia, M. L. Fernandez de Puelles, S. Gasparini, J. H.Hecq, P. Tranter and R. R. Kirby. 2010. A blooming jellyfish in the northeast Atlantic and Mediterranean. Biol.Lett. 6: 688-691 (Ricardo Anadon, University of Oviedo)	This statement does not seem to be appropriate for this paragraph which deals with direct sensitivity of egges and larvae to warming
547	50339	6	36	3	36	4	"high certainty" -- It would be preferable to use calibrated uncertainty language, perhaps a level of confidence, from the uncertainties guidance for authors. (Katharine Mach, IPCC WGII TSU)	It should have read "high confidence" but this detail has been lost from the revised text.
548	36116	6	36	4	36	4	Section 6.2.2.4.2. I suggest to add to this paragraph: The highest sensitivity of spawning, and first eggs and larval life stages of fish to warming was more generally verified for other fish species (Hermant et al., 2010). Reference: Hermant M., Lobry J., Poulard, J.C., Désaunay Y., Bonhommeau S., Le Pape O. (2010). Impact of warming on abundance and occurrence of flatfish populations in the Bay of Biscay (France). Journal of Sea Research 64 : 45-53. (Olivier Le Pape, Agrocampus Ouest)	This example has been included in table 6-6
549	41719	6	36	6	0	0	Intertidal zone? Does this example belong to Coastal chapter? (Rui Zhang, Xiamen University)	Intertidal zone is given here as a mere example of heterogeneous environments, however, the general statement refers to the entire ocean
550	36287	6	36	18	36	24	"Japanese Sea." I guess this should be "Japanese waters" or "areas off Japan Islands", etc.. It might cause the mixed-up with "Japan Sea" that is the marginal sea surrounded by Japanese Islands, Korea and Russia. Also, any references of saldine regime shift? (Sanae Chiba, JAMSTEC)	Thank you. What is meant is the Sea of Japan. Corrected
551	47123	6	36	18	36	24	Also include results from Chavez et al. (2003; Science) showing Pacific basin-wide regime shifts driven by multidecadal climate variability. Moreover, I believe there are some papers that suggest phytoplankton and zooplankton size-class changes may also be driving the regime shifts of anchovies and sardines, not just simply temperature contraints on their optimal growth and reproduction. (Vincent Saba, NOAA National Marine Fisheries Service)	Since both species have a similar food spectrum they would be equally affected by the change in size classes of food items. They clearly differ with repect to their thermal range.The Chavez et al example has different species (Sardinops sagax caerulea, Engraulis mordax)
552	50340	6	36	21	36	21	It would be helpful to clarify here if temperature change associated with natural variability, long-term climate change, or anthropogenic climate change is intended. (Katharine Mach, IPCC WGII TSU)	This example has been moved to Table 6-6, mentioning the interdecadal scale of warming.
553	47124	6	36	35	36	35	Please also consider citing and discussing (Stramma et al. 2012. Expansion of oxygen minimum zones may reduce available habitat for tropical pelagic fishes. Nature Climate Change 2, 33–37, doi:10.1038/nclimate1304) here. This paper looks at changing OMZs, habitat contraction, and the catchability of tuna and billfish. Not sure the best place for this, maybe in the following section? (Vincent Saba, NOAA National Marine Fisheries Service)	This paper has indeed been cited in the hypoxia section 6.3.3.
554	38778	6	36	37	0	39	OCLTT in my opinion is a interesting base for thinking about mechanistic limits in the distribution of species, and their predictions are robust. But not always OCLTT could predict the changes due to warming, and other mechanisms must be considered to explain (or search for explanations) observed changes, i.e. the lack of preys. For actual or future understanting we must have open mind to a broad panoplia of effects. At this respect I suggest to clarify the idea and open up the need for future progress (Ricardo Anadon, University of Oviedo)	This is a treatment of performance and sensitivities as well as underlying mechanisms at species levels. The ecosystem level processes are discussed further in 6.3.
555	50341	6	36	38	36	39	For this statement, the author team should additionally consider specifying a summary term for agreement. Also, it would be helpful to perhaps clarify further the nature of attribution as described here--attribution through understanding of mechanistic linkages and effects? (Katharine Mach, IPCC WGII TSU)	It has been said in the conclusions that physiological knowledge supports attribution of effects to climate change
556	37212	6	37	16	0	0	“arrest” should be “arrested development” (Erica Head, Fisheries and Oceans Canada)	what is meant is "metabolic arrest", developmental arrest has been added as another example.
557	41720	6	37	42	0	0	Section 6.2.2.4.3. There are too detailed molecular biolog and physiology information. I think the authors should simplify these contents and try to express them with "climate" view. (Rui Zhang, Xiamen University)	In our opinion, this biological and physiological information is necessary to correctly understand and attribute changes to climate impacts
558	39022	6	37	42	40	40	This rather long section contains a considerable amount of redundant material, i.e., material presented in one or more of the earlier sections. This section could be cut significantly without loss of information--but with the benefit of a better flow in the writing. Readers often tend to 'turn off' when they encounter redundant presentations of information, as is found in this section of the report. (George Somero , Stanford University)	Redundancies have been taken care of during the revision and condensation exercise.
559	50342	6	37	47	37	48	For this statement, the author team should additionally consider specifying a summary term for agreement. (Katharine Mach, IPCC WGII TSU)	Uncertainty language is now only used in conclusion sections.
560	37213	6	38	2	0	0	“Further processes affected through these mechanisms may include gonad maturation and egg fertilization (Kurihara and Shirayama, 2004; Havenhand et al. 2008; Reuter et al., 2011), larval development (Shirayama and Thornton, 2005; Kurihara, 2008) etc.” But – I note a recent publication that shows OA effects on krill egg hatching/development: “Further processes affected through these mechanisms may include gonad maturation and egg fertilization (Kurihara and Shirayama, 2004; Havenhand et al. 2008; Reuter et al., 2011), egg hatching (Kawaguchi et al. 2011), larval development (Shirayama and Thornton, 2005; Kurihara, 2008) etc.” (Erica Head, Fisheries and Oceans Canada)	This example has been included in Table 6-6.
561	37214	6	38	2	0	0	Reference: Kawaguchi, S., H. Kuihara, R. King, L. Hale, T. Berli, J.P. Robinson, A. Ishida, M. Wakita, P. Virtue, S. Nicol and A. Ishimatsu (2011) Will krill fare well under Southern Ocean acidification? Biol. Lett. 7, 288-291 (Erica Head, Fisheries and Oceans Canada)	This example has been included in Table 6-6.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
562	37215	6	38	10	0	0	"Accordingly, sensitivity to progressive OA is low in more active marine animals with a capacity to regulate ion and acid-base status, especially in fishes and cephalopods and also shallow-water crustaceans as well as copepods (Refs)." Apparently some copepods are not affected (e.g. Acartia tsuensis, Kurihara and Ishimatsu 2008), but these are coastal species, which may experience periods of reduced pH even now. Oceanic species, which might be more sensitive have only really been looked at with respect to egg production and hatching in fairly short-term (few days) experiments: longer incubations/exposures might elicit greater effects (e.g. Weydmann et al. 2012). Also, are krill shallow-water species when they are at the surface? Or is the author saying "shallow-water" when he/she means "coastal? In any case, I suggest omitting the generalization, thus: "Accordingly, sensitivity to progressive OA is low in more active marine animals with a capacity to regulate ion and acid-base status, especially in fishes and cephalopods and in some coastal crustacean and copepod species (Refs)." (Erica Head, Fisheries and Oceans Canada)	This text section has been shortened and clarified during the revision. Shallow water crustaceans are now called coastal crabs. The work on Calanus glacialis saw effects only at very low pH values which are outside the projected range.
563	37216	6	38	10	0	0	Reference: Weydmann, A, J.E. Søreide, S. Kwasniewski, S. Widdicombe. 2012. Influence of CO2-induced acidification on the reproduction of a key Arctic copepod Calanus glacialis. J. Exp. Mar. Biol. Ecol. 428, 39-42 (Erica Head, Fisheries and Oceans Canada)	We have checked the suggested reference and have considered the results in the respective Table (6-5 of SOD) and cited the paper in its (separate) reference list.
564	37217	6	38	41	0	0	"Further effects with the potential to cause reduced fitness comprise depressed immune functions (refs) or reductions in the maturation of sexual glands and in fertilization success (refs), or in the brooding success of echinoderms (refs) and reduced reproductive success for krill (Kawaguchi et al. 2011). Note the proposed addition/change in bold. (Erica Head, Fisheries and Oceans Canada)	Many of these processes have been listed in Table 6-6. The reference to Kawaguchi et al (2011) has been added (see reply to comment 560)
565	37218	6	38	41	0	0	Reference: Kawaguchi, S., H. Kuihara, R. King, L. Hale, T. Berli, J.P. Robinson, A. Ishida, M. Wakita, P. Virtue, S. Nicol and A. Ishimatsu (2011) Will krill fare well under Southern Ocean acidification? Biol. Lett. 7, 288-291 (Erica Head, Fisheries and Oceans Canada)	The reference to Kawaguchi et al (2011) has been added (see reply to comment 560)
566	47156	6	39	1	39	1	I believe there are methodological concerns associated with the Ries study and the crustacean results should be cited with caveats, because of the way calcification was measured (by weight) (Sarah Cooley , Woods Hole Oeanographic Institution)	This point is well taken, however, the question is whether the relative changes are still valid and believe that the way they are cited is appropriate. We cannot possibly go deep into methodological details of every study cited - if it was published as a peer-reviewed article, we assume that the results have undergone sufficient quality control.
567	43021	6	39	6	39	9	Should this read "respond negatively at higher CO2 levels"? (Cliff Law, NIWA)	This text section has been shortened and formulated more clearly during the revision.
568	38779	6	39	37	0	39	Instead the reference talks about future, probably this is a interesting reference [Silverman, J. Lazar, B. Cao, L. Caldeira, K. Erez, J. 2009 Coral reefs may start dissolving when atmospheric CO2 doubles. Geophysical Research. Letters, 36 (L05606): 1-5] because reinforce the idea of decline of corals in all the world. The actual observations fits with projections for these ecosystems, and could be used as signals for future predictable events (Ricardo Anadon, University of Oviedo)	This is an ecosystem level projection that is dealt with in the chapter and the cross-chapter box.
569	47157	6	40	7	40	8	Should there be some comment here about the adaptive capacity for organisms via evolution or other adaptation? It's discussed later but perhaps a road sign to that section would be helpful. (Sarah Cooley , Woods Hole Oeanographic Institution)	It is now discussed earlier: The capacities of acclimatization processes and their limits in shifting tolerances, as well as the long-term evolutionary consequences of such processes in relation to emission scenarios remain to be explored.
570	50343	6	40	28	40	33	For the statements, the author team should additionally consider specifying summary terms for agreement. Alternatively, presenting a level of confidence without summary terms for evidence and agreement is another option to consider. (Katharine Mach, IPCC WGII TSU)	We have now largely confined the use of uncertainty language to the conclusion sections and follow the various options.
571	40430	6	40	39	0	0	Incomplete sentence. (Laura Petes, National Oceanic and Atmospheric Administration)	agreed and modified
572	38633	6	40	43	42	45	This section on the sensitivity of reef-building corals to climate change seems rather long to me - I think the key issues could be summarised much more succinctly. (Janice Lough, Australian Institute of Marine Science)	The overall text including this section has been shortened and formulated more clearly during the revision.
573	40431	6	40	45	0	0	Rephrase: "Warm water coral reef ecosystems are higly biodiverse, housing . . ." (Laura Petes, National Oceanic and Atmospheric Administration)	This detail has been lost from the revised text.
574	38634	6	41	4	41	6	Do not think that "sudden changes in....." is the best descriptor of these potential causes of coral bleaching. "unusual and extreme" is probably more accurate. (Janice Lough, Australian Institute of Marine Science)	The word sudden has been replaced by "unusual" extreme does not quite reflect the fact that small changes in temperature are causative.
575	50344	6	41	33	41	35	As possible, it would be preferable to provide an indication of the relevant climate/socio-economic scenarios for this statement. (Katharine Mach, IPCC WGII TSU)	Scenarios are SRES A2a and B2a. This information has been added.
576	40432	6	41	35	41	36	The emphasis (low agreement, limited evidence) makes it sound like this Is a major conclusion - that corals CAN rapidly acclimate; whereas most evidence suggests the opposite. Is there a way to clarify that through shifting the emphases and/or where confidence/agreement statements are placed throughout this paragraph? (Laura Petes, National Oceanic and Atmospheric Administration)	Confidence statement has been removed here. The sentence has been replaced by "It is under debate whether corals adapt to warming ..."
577	46499	6	41	35	41	36	This is an odd way to express this. In Chp 30 they would say there is robust evidence and high agreement that corals will be unable to adapt to unprecedented levels of heat stress. (Neville Smith, Bureau of Meteorology)	Confidence statement has been removed here. The sentence has been replaced by " It is under debate whether corals adapt to warming ..."
578	50345	6	41	38	41	39	It may be helpful to also indicate the role of stressors other than temperature extremes in trends observed to date. (Katharine Mach, IPCC WGII TSU)	The role of several stressors is indicated in the revised text.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
579	50346	6	42	1	42	1	It would be beneficial to potentially indicate further if this is an outcome expected across all scenarios of future climate. (Katharine Mach, IPCC WGII TSU)	This statement hs been lost from the revised text.
580	46500	6	42	1	42	4	This is a different twist. They are noting that while individual species may not be able to adapt, complex systems may. (Neville Smith, Bureau of Meteorology)	This is misunderstanding. It is the other way round.
581	50347	6	42	8	42	8	For this statement, the author team should additionally consider specifying a summary term for agreement. (Katharine Mach, IPCC WGII TSU)	We have now largely confined the use of uncertainty language to the conclusion sections.
582	38635	6	42	14	42	16	The study of Fabricius et al (2011) does not provide evidence of "much lower growth, calcification". The main effects were dramatic reduction in species diversity (though little change in the amount of coral cover) with increasing OA. (Janice Lough, Australian Institute of Marine Science)	The emphasis has been shifted and the word "much" removed.
583	38780	6	42	33	0	45	I suggest to incorporate as interesting reference for the future of cold water corals the paper [Guinotte, J. M. Orr, J. Cairns, S. Freiwald, A. Morgan, L. George, R. 2006. Will human-induced changes in seawater chemistry alter the distribution of deep-sea scleractinian corals? Frontiers in Ecology and the Environment 4(3): 141-146] as analyse the ASH depth during this century in all oceans in relation to this very interestings benthic communities (Ricardo Anadon, University of Oviedo)	The role of the aragonite horizon in characterzing the distribution of cold water corals is not clear. Therefore we have not discussed this extensively but this reference is in the chapter.
584	40433	6	42	35	0	0	Remove "very sensibly," as that anthropomorphizes the response. (Laura Petes, National Oceanic and Atmospheric Administration)	We now write " strongly" instead.
585	47125	6	42	50	42	51	Being an ectotherm (reptiles, amphibians, fishes) does not mean temperature-dependent sex determination. Please rephrase. It is true, however, that all 7 species of sea turtle undergo temperature-dependent sex determination. (Vincent Saba, NOAA National Marine Fisheries Service)	This text section has been shortened and clarified during the revision.
586	47158	6	42	50	42	54	This paragraph is very odd, starting with sea turtles yet introducing a section touching on many higher organisms. I suggest rewriting it to be more general and a better introduction to the section. (Sarah Cooley , Woods Hole Oeanographic Institution)	This text section has been shortened and clarified during the revision.
587	37528	6	43	2	43	2	New text proposed: Hypoxic habitat compression for fishes may enhance foraging opportunities for hypoxia-tolerant species such as air breathing mammals (E.L. Hazen, Craig J.K., Good C.P., Crowder L.B. 2009. Vertical distribution of fish biomass in hypoxic waters on the Gulf of Mexico Shelf. Marine Ecology Progress Series 375: 195-207.) (Elliott Hazen, National Oceanic and Atmospheric Association)	Adopted, new reference added
588	47126	6	43	2	43	5	Not all sea turtles are "completely ectothermic." The leatherback sea turtle is the exception. These sea turtles (sub-adults and adults) can maintane core-body temperatures above ambient while in cold, temperate waters. Leatherbacks are seen in near-freezing waters off the coast of Nova Scotia in the late fall. They are essentially, facultative homeotherms. See Paladino et al. (1990, Nature). (Vincent Saba, NOAA National Marine Fisheries Service)	Thank you for this comment. The text has been modified to not exclude the potential for some thermal independence in large turtles. We now say : "Among them, the reptiles, being ectotherms, are more responsive to temperature effects." see also 6.2.2.
589	37529	6	43	12	43	12	New text proposed: Range shifts in prey distributions and resultant oceanic habitat may have greater effects on central place foragers that are tied to land between trips compared to oceanic migrators as physiological costs of finding prey increases (Crozet et al. 2012; Hazen et al. Predicted Habitat Shifts of Pacific Top Predators in a Changing Climate, in press, Nature Climate Change). (Elliott Hazen, National Oceanic and Atmospheric Association)	This statement and additional reference have been included, but moved to 6.2.2.
590	37219	6	43	14	0	0	I suggest an addition to this paragraph, thus:“As well, in polar and sub-polar regions the abundance and composition of planktonic prey (krill, copepods) is linked to sea-ice extent and water temperatures, with significant impacts on reproductive success and survival for dependent seabird (Barbraud and Welmerskirsch, 2001; Kitaysky and Golubova, 2000) and mammal populations (Bluhm and Gradinger 2008; Nicol et al. 2008). References Barbraud, C. and H. Weimerskirch. 2001. Emperor penguins and climate change. Nature. 411, 183-186 Bluhm, B.A. and R.Gradinger. 2008. Regional variability in food availability for Arctic marine mammals. Ecological Applications 18:S77–S96 Kitaysky, A.S. and E.G. Golubova. Climate change causes contrasting trends in reproductive performance of planktivorous and piscivorous alcids. Journal of Animal Ecology. 69, 248-262 Nicol, S., A. Worby and R. Leaper. 2008. Changes in the Antarctic sea ice ecosystem: potential effects on krill and baleen whales. Marine and Freshwater Research 59, 361–382 (Erica Head, Fisheries and Oceans Canada)	The principle message is included, such detail seems to be more appropriate for the polar chapter.
591	36117	6	43	19	44	7	Section 6.2.2.4.5. Concerning the Sea turtles warnings concerning the effect of nest warming on sex determinism in eggs (Booth DT and Astill K (2001) Australian Journal of zoology 49:389-396 (Olivier Le Pape, Agrocampus Ouest)	We feel that including this reference will not change the message and refrain from adding it due to space limitations.
592	47127	6	43	25	43	25	Please also cite and discuss a recent paper by Saba et al. (2012) showing a projected decline in the eastern Pacific leatherback population in response to climate change. (Saba, V.S., Stock, C.A., Spotila, J.R., Paladino, F.P., Santidrián-Tomillo, P. 2012. Projected response of an endangered marine turtle population to climate change. Nature Climate Change, doi:10.1038/NCLIMATE1582.) (Vincent Saba, NOAA National Marine Fisheries Service)	This reference has been included and integrated.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
593	47128	6	43	33	43	35	But this assumes that climate change will only act on the sex ratio of sea turtles. The nesting population projections in Saba et al. (2012) show only a small increase in the proportion of females up to the year 2100. This is due to the stronger influence of rainfall, as opposed to air temperature, on the deep nest temperatures that drive sex ratio. Warming air temperatures are projected to substantially decrease both hatching success and emergence rate of eastern Pacific leatherbacks in Costa Rica due to a warming of the upper, surface layers of their nests. Therefore, in this context, sea turtle populations may be very sensitive to a 2.5 degree C increase in air temperature in the nesting beaches via reduced nest success, not sex rato, and thus would not be immune to climate change. Changes in rainfall, not just air temperture, must be considered for the nesting beach habitats of sea turtles. The projections in Saba et al. 2012 were based empirical studies of climate, local weather, and leatherback ecology in both the ocean and nesting beach. Please cite the recent paper (Santidrián Tomillo, P. et al. Climate driven egg and hatchling mortality threaten survival of eastern Pacific leatherback turtles. PLoS One 7, e37602 (2012)) that describes the emprirical study showing the effects of air temperature and rainfall on nest success. Also, consider citing and discussing this dissertation (Sieg, A. E. Physiological Constraints on the Ecology of Activity-Limited Ectotherms. (Dissertation, Drexel Univ., 2010).) that describes the robust effect of rainfall, not air temperature, on the sex ratio of leatherback nests. (Vincent Saba, NOAA National Marine Fisheries Service)	We appreciate this focus in leatherbacks and have considered those aspects in the revision. We feel that further inclusion of these undoubtedly important but rather specialized studies would make the section about turtles overloaded with details and issues that are too specific for this general chapter.
594	46886	6	43	38	43	38	Explain SST in full when it first appears. (Genevra Harker, HarmonicQuay Ltd)	Has been done at the beginning of the Chapter
595	47129	6	43	43	43	43	Also consider citing and discussing primary productivity and surface chlorophyll-a links to sea turtle reproductive ecology and oceanic distribution (Saba, V.S., Spotila, J.R., Chavez, F.P., Musick, J.A. 2008. Bottom-up and climatic forcing on the worldwide population of leatherback turtles. Ecology 89 (5), 1414-1427), (Mansfield, K.L., Saba, V.S., Keinath, J.A., Musick, J.A. 2009. Satellite tracking reveals a dichotomy in migration strategies among juvenile loggerhead turtles in the Northwest Atlantic. Marine Biology, 156, 2555-2570.) Also work by Polovina regarding juvenile loggerhead movement and location associated with meso-scale eddies (Polovina JJ, Kobayashi DR, Parker D, Seki MP, Balazs GH (2000) Turtles on the edge: movement of loggerhead turtles (Caretta caretta) along oceanic fronts, spanning longline fishing grounds in the central North PaciWc, 1997–1998. Fish Oceanogr 9(1):71–82; Polovina J, Uchida I, Balazs GH, Howell EA, Parker D, Dutton P (2006) The Kuroshio Extension Bifurcation Region: a pelagic hotspot for juvenile loggerhead sea turtles. Deep-Sea Res II 53:326–339). (Vincent Saba, NOAA National Marine Fisheries Service)	We feel that inclusion of these undoubtedly important but rather specialized studies would make the section about turtles overloaded with details and issues that are too specific for this general chapter.
596	47130	6	44	1	44	2	The Van Houtan and Halley (2011) only investigated loggerheads, not hawksbills. (Vincent Saba, NOAA National Marine Fisheries Service)	We feel that inclusion of these undoubtedly important but rather specialized studies would make the section about turtles overloaded with details and issues that are too specific for this general chapter. We now refrain from emphasizing individal species and only discuss examples.
597	47131	6	44	4	44	7	I think this statement should be reworded. We don't know if hawksbills will be more impacted by changes in developmental habitat than other sea turtles because we don't have enough conclusive data. For example, the early life history migration and ecology of leatherbacks is virtually unknown and has been limited to laboratory based studies. Moreover, leatherbacks in the eastern Pacific appear to have a higher nestsite fidelity than those in the Western Atlantic. I suggest removing the entire sentence. (Vincent Saba, NOAA National Marine Fisheries Service)	Agreed. We now refrain from emphasizing individal species.
598	38536	6	44	12	45	54	I'm concerned about the style used when writing the common names of animals. Sometimes, both words in the name are capitalize (i.e Emperor Penguin), sometimes just the first (Humpback whale), sometimes neither (razorbill). My understanding of the correct style is that common names should not be capitalized unless the name contains a proper name (for example, Atlantic puffin). (Andrew Pershing, University of Maine)	Agreed. We now payed attention to this style issue and only discuss examples.
599	52557	6	44	16	0	0	The ranges of species are extending southwards. (Delete the following) That some seabird species are extending their ranges southward, (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Agreed. The text has been revised accordingly.
600	52558	6	44	17	0	0	Breeding seasons are starting earlier and extending longer. NB. Species do not "extend their breeding season or geographic ranges". This implies active choice at the species level to do this. The reality is that a species responds to environmental drivers by individuals reproducing earlier or longer or reproducing, recruiting and surviving in a poleward sense. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Agreed. The text has been revised accordingly.
601	39122	6	44	17	44	17	Updated reference would be Chambers et al. 2011. Observed and predicted effects of climate on Australian seabirds. Emu 111:235-251. (Lynda Chambers, Australian Bureau of Meteorology)	Thank you. This reference has been added.
602	37530	6	44	52	44	52	Predicted southward migration of the Antarctic Circumpolar Current has been shown to lead to increased foraging time and decreased breeding success in King Penguins (sp.) from Kerguelen Island (check - Peron et al. 2012 Projected poleward shift of king penguins' (Aptenodytes patagonicus) foraging range at the Crozet Islands, southern Indian Ocean PNAS vol. 279 no. 1738 2515-2523) (Elliott Hazen, National Oceanic and Atmospheric Association)	This aspect of shifting foraging ranges has been mentioned and the reference included.
603	47656	6	45	7	45	7	some mention of the increase in sound transmission under acidification here is warranted. (John Dunne, NOAA/GFDL)	This aspect has now been mentioned and a reference included.
604	46887	6	45	44	45	44	Spelling: seasonal. (Genevra Harker, HarmonicQuay Ltd)	Thank you
605	36876	6	46	13	46	22	remove citations from the conclusions section. (all citations are appropriate for the preceding sections but not here) (Antonio Bode, Instituto Espanol de Oceanografia)	agreed and modified
606	50348	6	46	18	46	18	It would be helpful to indicate more precisely what is meant by "trends" here--trends in what exactly? (Katharine Mach, IPCC WGII TSU)	This text section has been moved, shortened and clarified during the revision.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
607	52559	6	46	20	0	0	..unequivocal (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Agreed. This detail has been lost during the revision.
608	50349	6	46	20	46	21	The author team should additionally consider specifying a summary term for agreement for the statement on line 20. Then, it would be beneficial to characterize the described "attribution" and "effects" slightly more specifically--attribution and effects of what exactly? (Katharine Mach, IPCC WGII TSU)	This text section has been shortened and clarified during the revision.
609	39465	6	46	25	47	5	My expertise is not in marine biology, so I read the previous sections (and learned a lot!) but I can't comment on the details of the content. Nevertheless, this conclusion section is excellent - concise and very readable, and it is clear how the science described in the earlier subsections relates to the important messages. For me, this section 6.2 is one of the nicest bits of 'classic IPCC' work that I've read so far in the WGII report - with the caveat that I don't know the content of the science cited, the whole section is a well-written critical review of a diverse (and worldwide) body of current science, with proper synthesis at the end. Minuscule issues: sentence on line 54 needs a capital letter. I would break the first paragraph at line 33, and perhaps move lines 49-52 to that opening paragraph (line 32), to keep all the conceptual/methodological information together, avoiding the slightly repetitive feel that the current structure gives. The OA text in para 1 might then fit smoothly at line 48. (Sarah Cornell, Stockholm Resilience Centre)	Thank you for your strong support. The errors spotted have been amended. This text section has been shortened and clarified during the revision.
610	38537	6	46	33	0	0	"medium confidence" Again, more abuse of the IPCC style. Futhermore, I'm 100% certain that some species will be tolerant or else the PETM would've wiped out life on the planet. (Andrew Pershing, University of Maine)	This text section has been shortened and clarified during the revision.
611	43022	6	46	40	46	40	"Sensitivity is highest at the highest complexity levels, organism & ecosystem….". This seems a rather generalised statement that contradicts information in the previous section. Evidence was presented that certain groups of more complex organisms have some physiological control which provides a degree of adaptability to changes in oxygen availability and pH, whereas less developed organisms do not have such flexible physiology. Consequently this sentence seems to be in error. (Cliff Law, NIWA)	This text section has been shortened and clarified during the revision.
612	43023	6	46	49	46	0	It may be better to treat mulitple stressor interaction seperately and so remove the examples used in the previous sections (for example, Pg 40, line 20-22; line 37-38) & combine them in one place (Cliff Law, NIWA)	In this conclusion section, we draw conclusions based on the material and examples given in the preceding sections. This is now even more so as this text section has been shortened and clarified during the revision.
613	36877	6	46	49	46	54	remove citations from the conclusions section. (all citations are appropriate for the preceding sections but not here) (Antonio Bode, Instituto Espanol de Oceanografia)	agreed and modified
614	52560	6	46	54	0	0	Thermal (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Corrected. Thank you
615	46502	6	47	0	0	0	At this point I am realising the Chapter is rather different from the agreed Outline. Probably better. (Neville Smith, Bureau of Meteorology)	Thank you for your strong support.
616	36118	6	47	5	47	5	Section 6.2.2.5. last sentence. If exact consequences of synergetic pressures are not known with a good level of confidence, the reality of synergetic effects is well established. I suggest a conclusion similar to that of section 6.3.5.1. page 60, line 5-6 (Olivier Le Pape, Agrocampus Ouest)	Agreed. We now say quantitative conclusions have low confidence.
617	50350	6	47	5	47	5	For this statement, the author team should additionally consider specifying a summary term for agreement. (Katharine Mach, IPCC WGII TSU)	Agreed. The text has been revised accordingly.
618	41721	6	47	8	0	0	Section 6.3. Although it is very good reviewing, I feel there are lots of overlapping between 6.2 and 6.3. Why not combine them to save space? (Rui Zhang, Xiamen University)	6.2 has the discussion of mechanisms and theory while 6.3 presents observations, empirical evidence and interpretation. So,we have kept the current structure in the revisions.
619	47296	6	47	16	0	0	Section 6.3.1. I would say the "high agreement, medium evidence" for episodic effects like the volcanic eruption and the "medium evidence and medium confidence" for ENSO effects are almost backwards. There is no question that the elevated productivity observed in the equatorial Pacific in 1998 was associated with the El Niño to La Niña transition, although there may have been unique circumstances at the time that were not ENSO related. I am not disputing Hamme's inference regarding the volcanic source of Fe, but there is very little other evidence for such episodic events. The only other paper I know of that attempts to connect a phytoplankton bloom in the Gulf of Alaska to a volcanic eruption (Boyd et al 1998, Global Biogeochemical Cycles 12: 429) is quite speculative, as are all of the papers that try to tie blooms to aeolian dust deposition 'events'. (James Christian, Government of Canada)	We deleted the e.g. of volcanic eruption while providing other evidences that show strong relationship betweeen NPP and ocean conditions. because volcanic eruption is not the main point here.
620	47297	6	47	16	0	0	Section 6.3.1. I think one should not try too hard to tie observed trends in ocean colour or productivity to AGW. The expansion of areas of low chlorophyll (Polovina, Signorini) may well be real but the time series are as yet too short to infer that this is an AGW signal and not natural variability. Behrenfeld et al 2006 make claims for AGW effects based on observations of ENSO variability that I believe are invalid. The signal they observe is real enough, but it is almost entirely driven by ENSO. They attempt to tie this to the effects of greater stratification under AGW, but there is no reason why the processes that will drive changes in productivity with increasing stratification in the subtropical and mid-latitude oceans should be analogous to the overwhelmingly tropical signal that their historical relationship is based on. They obtain a strong correlation globally simply because ENSO overwhelmingly dominates interannual variability in the contemporary world. Again the data records are simply too short to make robust inferences about the implications for AGW. Also, "Increased frequency of or transition to permanent El Niño favorable conditions in a warmer future world" is not a robust prediction. There is some evidence that this is likely to occur but the jury is still out on this issue (see Vecchi, G. A., and A. T. Wittenberg, El Nino and our future climate: where do we stand?, WIREs Clim. Change, 1, 260-270, 2010). (James Christian, Government of Canada)	This is much appreciated and in line with our thinking. We have expressed our methodlogical concerns and those on the limited lengths of time series here and elsewhere (6.1.3.).

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
621	36288	6	47	16	48	14	Concerning the discussion of desagreement in trend of NPP between satellites and in situ observations, besides the limitation of in situ data and methodological issues, difference in the observation time-scale should be considered. For example, Figure 6-10 shows time-series of 1990-2010 while data of Behrenfeld et al (2006) is 1998-2006. Thos of Boyce et al. (2010) is much longer. If looking at the trend during 1998-2006 on the Figure 10, I cannot see any obvious increasing trend either in BATS and HOT. Also, I believe decadal scale Chl a data (not NPP though) should be available in subarctic ocean site, e.g. St. P, CPR etc., for comparison. (Sanae Chiba, JAMSTEC)	This is much appreciated and in line with our thinking. We have expressed our methodlogical concerns and those on the limited lengths of time series here and elsewhere (6.1.3.).
622	35965	6	47	18	0	0	Continued economic use of the ocean as a food source... (economic use for resource extraction does not depend on PP) (Frank Whitney, Institute of Ocean Sciences)	This detail has been lost from the revised text and is developed elsewhere in the chapter..
623	39466	6	47	21	0	0	either capitalise all the HNLC, or write in lower case - 'high nitrate-low chlorophyll' (Sarah Cornell, Stockholm Resilience Centre)	We went for lower case.
624	50352	6	47	23	47	23	For this statement, the author team should additionally consider specifying a summary term for agreement. (Katharine Mach, IPCC WGII TSU)	We have now largely confined the use of uncertainty language to the conclusion sections.
625	38782	6	47	27	0	29	I suggest to incorporate the idea that local and regional changes in primary production, must of them in coastal or onshelf waters, can not be traced with suitability -confidence - and this changes could be highly significative in respect to the local resources (fisheries, aquaculture) and for the economy of local people. For instance in Northwest Iberian Península some long term data suggest a rise in NPP in some parts and decreasing in others [Bode, A. Anadón, R. Morán, X.A.G. Nogueira, E. Teira, E. Varela, M. 2011. Decadal variability in chlorophyll and primary production off NW Spain. Climate Res., 48: 293-305] (Ricardo Anadon, University of Oviedo)	Our statement is focusing on the general trend, which should be valid given the evidence we provided. We emphasized in the text that this is representing the large-scale trend.
626	36119	6	47	27	47	38	Section 6.3.1. increase in El nino events is not in agreement with remarks elsewhere in the report (see remark 1 : increase upwelling (chapter 5, page 10; chapter 6 pagses 7, 13 & 62) to no trend or even decrease (chapter 30, page 15, 16, 19-22, chapter 6, page 21 & 47) (Olivier Le Pape, Agrocampus Ouest)	The text points out the conditions under which global ocean NPP may decrease, with a balanced view of possible contributions by El Nino. We emphasized the possibility of occurrence of these changes under climate change.
627	48445	6	47	27	47	38	It think the chapter should clearly state that changes such as the ones discussed here cannot be reliably attributed to climate change (e.g., Henson et al., 2010. Detection of anthropogenic climate change in satellite records of ocean chlorophyll and productivity, Biogeosciences 7 (2). (Charles Stock, NOAA/Geophysical Fluid Dynamics Laboratory)	We added: Changes such as the ones discussed here can thus not be reliably attributed to climate change (e.g., Henson et al., 2010).
628	47298	6	47	29	47	29	WGII Ch 3: I think this is supposed to be WG1 (or maybe it's WG2 Ch 30) (James Christian, Government of Canada)	Amended. Reference to WGI ch. 3 is correct.
629	50351	6	47	30	47	30	A conditional framing for potential changes in El Nino and corresponding conditional effects for NPP is implied but could perhaps be further emphasized as appropriate. (Katharine Mach, IPCC WGII TSU)	The text has been revised accordingly.
630	46501	6	47	30	47	32	Why highlight the El Nino option when there is no evidence to suggest either are likely. (Neville Smith, Bureau of Meteorology)	We added: Changes such as the ones discussed here can thus not be reliably attributed to climate change (e.g., Henson et al., 2010) but need to be discussed to represent the variety of views in the community.
631	38781	6	47	31	0	0	The phrase refers to the expansion of subtropical gyre, but probably the circulation has not changed and the subtropical gyre not expand, as suggested by Longhurst (Ecological geography of the sea, 2nd ed. 2007). This author discuss the asignation of the expansion of the oligotrophic low chlorophyll areas descrived by Polovina as increasing subtropical gyre in in any of the ways that can be described, oceanic surface height or otres. I suggest that this idea be qualified in a more general point of view, i.e. only expansion of low chlorophyll areas. (Ricardo Anadon, University of Oviedo)	Agreed. expansion of ocean gyres has been replaced by expansion of stratification.
632	35966	6	47	40	47	48	Is my analysis of nutrient drawdown in the subarctic Pacific relevant to this discussion? I suggest no detectable change in seasonal nutrient utilization between 1987-2010 but do show how bidecadal oscillations can confuse interpretations (Whitney 2011, J. Oceanogr.) (Frank Whitney, Institute of Ocean Sciences)	This detail has been lost from the revised text.
633	47657	6	48	5	48	5	again, this 'half npp estimate is wrong, and should be more like one quarter if recent ocean estimates of global productivity (36-78 PgC a-1; Carr et al. (2006) and land estimates (150–175 PgC a-1; Welp et al., 2011) are to be believed. (John Dunne, NOAA/GFDL)	We have removed this controversial issue from the chapter.
634	39467	6	48	5	48	6	This first sentence of the paragraph would be better as the opening sentence of the whole section. (Sarah Cornell, Stockholm Resilience Centre)	This detail has been lost from the revised text.
635	36868	6	48	5	48	14	same comment as for chapter 6, page 31, lines 1-28 (Antonio Bode, Instituto Espanol de Oceanografia)	This statement and additional references have been incorporated into the text of 6.2. following the earlier comment.
636	41722	6	48	5	48	14	Is this paragraph simplified version of previous two paragraphs? (Rui Zhang, Xiamen University)	The text has been revised and section structure changed.
637	50353	6	48	8	48	8	For the "trends" described here, would be helpful to clarify more specifically if these are increasing trends. (Katharine Mach, IPCC WGII TSU)	The text has been revised and section structure changed.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
638	50354	6	48	10	48	14	For these statements, the author team should additionally consider specifying summary terms for agreement. Also, for the trend described on line 11, it would be helpful to indicate more specifically the geographic scope of this trend (global?) and the degree to which it could be associated with natural variability versus climate change. (Katharine Mach, IPCC WGII TSU)	For the first statement, it is based on few offshore time-series and is an indication of regional changes in NPP in the Pacific and Atlantic Oceans (Subtropical N Pacific Gyre, Subtropical NW Atlantic Gyre, and Coastal Upwelling system). Tthere are high variations in the overall trends of change in NPP from these time-series, suggesting "low to medium agreement". It seems that there is low confidence in attributing these changes to climate change because of the confounding factors from natural climate variability and sampling. It has been emphasized that we discuss global trends and that agreement is low on these trends.
639	52561	6	48	23	0	0	There are other papers to support this Genner et al, 2004 Proc. Roy. Soc B. and Simpson et al, 2011 Current Biology. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	References have been included.
640	50355	6	48	27	0	0	Section 6.3.2.1. The author team may wish to consider further coordinating assessment in this section with treatment in chapter 30, reducing overlap and providing cross-reference as appropriate. (Katharine Mach, IPCC WGII TSU)	We have revised and emphasize general principles more in this whole section (6.3.2.), dealing with specific examples moved to a table. Specifically, we focus on long term range shifts and changes in community structure and seasonality of phytoplankton communities. We describe major changes: northward range shifts, changes in abundance beteween dinoflagellates and diatoms. We then say that most evidence comes from the North Atlantic. We then draw conclusions based on this example and we did this similarly for ocean benthos.
641	52562	6	48	35	0	0	(should read) The range of warm water copepods expanded by 10 ..... (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Agreed and amended.
642	52563	6	48	35	0	0	Copepods did not expand their range! (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We now write that copepods "shift" their range limit instead of expand their range.
643	37220	6	48	42	0	0	“dinoflagellates in relation to diatoms to warming, increased summer windiness and thus, turbulence.” I suggest adding to this paragraph “In the North West Atlantic sub-polar gyre, the prevailing flow is from the north, so that southerly plankton forms cannot easily colonize as temperatures rise. Thus, warming temperatures between the 1980s and mid-2000s were accompanied by increasing phytoplankton levels, due to increased stratification, but paradoxically, at the same time two arctic Calanus species became more abundant, due to increased influx of arctic water from the north (Head and Pepin 2010).” Reference Head, E.J.H. and P. Pepin. 2010. Spatial and inter-decadal variability in plankton abundance and composition in the Northwest Atlantic (1958-2006). J. Plankton Res. 32, 1633-1648 I suggest an addition to this paragraph, thus:“As well, in polar and sub-polar regions the abundance and composition of planktonic prey (krill, copepods) is linked to sea-ice extent and water temperatures, with significant impacts on reproductive success and survival for dependent seabird (Barbraud and Welmerskirsch, 2001; Kitaysky and Golubova, 2000) and mammal populations (Bluhm and Gradinger 2008; Nicol et al. 2008). References Barbraud, C. and H. Weimerskirch. 2001. Emperor penguins and climate change. Nature. 411, 183-186 Bluhm, B.A. and R.Gradinger. 2008. Regional variability in food availability for Arctic marine mammals. Ecological Applications 18:S77–S96 Kitaysky, A.S. and E.G. Golubova. Climate change causes contrasting trends in reproductive performance of planktivorous and piscivorous alcids. Journal of Animal Ecology. 69, 248-262 Nicol, S., A. Worby and R. Leaper. 2008. Changes in the Antarctic sea ice ecosystem: potential effects on krill and baleen whales. Marine and Freshwater Research 59, 361–382 (Erica Head, Fisheries and Oceans Canada)	We have adopted the North west Atlantic issue and moved it to the respective text below. The principles of the polar observations are discussed elsewhere and in more generic terms as there is a polar chapter.
644	52564	6	48	53	0	0	Perry et al, 2005. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	This text is for terrestrial species, reference does not fit. Details have been lost in the revision.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
645	38539	6	49	0	0	0	I realize that this section is about "temperature-mediated" change, but I think that focusing only on temperature is a mistake. Temperature has direct effects on organisms through their physiology, emphasized throughout the chapter. However, warming in the ocean also leads to changes in the density structure, notably increased stratification, that can impact ecosystems. At higher latitudes, increased stratification will be further enhanced by reduced salinities due to increases in precipitation and melting. The response of the Northwest Atlantic Shelf to a shelf-wide freshening event in the 1990s provides a good example of how freshening and more generally, stratification can impact temperate and subpolar ecosystems. In particular, the Gulf of Maine was considerably fresher throughout the 1990s, likely the result of increased freshwater export from the Canadian Arctic (Smith et al. 2001, Mountain 2004, Greene & Pershing 2007, MERCINA 2012). The reduction in surface salinity and increase in stratification resulted in enhanced phytoplankton abundance, a larger and later fall bloom, increased abundance of small copepods, and a decrease in the large copepod Calanus finmarchicus (Pershing et al. 2005). The changes in the plankton community propagated up through the food web, leading to reduced survival of larval cod (Mountain & Kane 2010), fewer right whale calves (Greene et al. 2003), but increased herring abundance (Greene & Pershing 2007). Ecosystems on the Northwest Atlantic Shelf both upstream and downstream from the Gulf of Maine exhibited similar responses to the 1990s freshening (de Young et al. 2004, Pershing et al. 2010). de Young B, Harris RP, Alheit J, Beaugrand G, Mantua N, Shannon L (2004) Detecting regime shifts in the ocean: Data considerations. Progress in Oceanography 60:143-164 Greene CH, Pershing AJ (2007) Climate drives sea change. Science 315:1084-1085 Greene CH, Pershing AJ, Kenney RD, Jossi JW (2003) Impact of climate variability on the recovery of endangered North Atlantic right whales. Oceanography 16:96-101 MERCINA (2012) Recent Arctic climate change and its remote forcing of Northwest Atlantic Shelf ecosystems. Oceanography. http://dx.doi.org/10.5670/oceanog.2012.64 Mountain DG (2004) Variability of the water properties in NAFO subareas 5 and 6 during the 1990s. J Northw Atl Fish Sci 34:103-112 Mountain DG, Kane J (2010) Major changes in the Georges Bank ecosystem, 1980s to the 1990s. Marine Ecology Progress Series 398:81-91 Pershing AJ, Greene CH, Jossi JW, O'Brien L, Brodziak JKT, Bailey. BA (2005) Interdecadal variability in the Gulf of Maine zooplankton community with potential impacts on fish recruitment. ICES Journal of Marine Science 62:1511-1523 Pershing AJ, Head EHJ, Greene CH, Jossi JW (2010) Pattern and scale of variability among Northwest Atlantic Shelf plankton communities. Journal of Plankton Research 32:1675-1684 Smith PC, Houghton RW, Fairbanks RG, Mountain DG (2001) Interannual variability of boundary fluxes and water mass properties in the Gulf of Maine and on Georges Bank: 1993–97. Deep Sea Research II 48:37-70 (Andrew Pershing, University of Maine)	Thank you for your suggestions. We deal with the main factors and then, their integration for a clearer picture. We refer to density driven stratification (temperature and freshening somewhere else. We have now integrated an excerpt of these important details of the Northwest atlantic system into the chapter.
646	37221	6	49	3	0	0	"For example, between 1960 and 2000 the northwest Atlantic etc." The way this is written is misleading. Here is my suggested change "For example, between 1960 and 2000 the Newfoundland Shelf in the northwest Atlantic saw an increase in the abundance of arctic boreal plankton species, notably the copepods Calanus hyperboreus (Kroyer), Calanus glacialis (Jaschnov) and the dinoflagellate Ceratium arcticum due to an increased contribution of arctic water via the shelf branch of the Labrador Current (Johns et al. 2001). In 1996, a dramatic drop in the NAO allowed a flood of cool Labrador slope water to round the Tail of the Grand Bank (Greene and Pershing, 2003), carrying C. hyperboreus along the Scotian shelf-break, to reach Georges Bank 2 years later (Johns et al. 2001)." Reference Greene, C.H. and A.J. Pershing. 2003. The flip-side of the North Atlantic Oscillation and modal shifts in slope-water circulation patterns Limnol. Oceanogr., 48, 319-322 (Erica Head, Fisheries and Oceans Canada)	Thank you for these amendments which we adopted to what is now table 6-7.
647	38538	6	49	26	0	0	"trends in body size (6.2.2.4)"--I don't recall seeing body size trends discussed. (Andrew Pershing, University of Maine)	We cited the relevant sections where these principles are being discussed.
648	37222	6	49	29	0	0	"which are major contributors to carbon export (Armbrust 2009)." Suggested additional sentence after this one "Moran et al. (2010) also found that temperature alone (independent of nutrient loading) could explain 73% of the variance in the relative contribution of small cells (picophytoplankton) to total phytoplankton biomass in the eastern and western temperate North Atlantic over a temperature range of -0.6 to 22oC." Reference Moran, X.A.G., A. Lopez-Urrutia, A. Calvo-Diaz and W.K.W. Li. 2010. Increasing importance of small phytoplankton in a warmer ocean. Global Change Biology. 16, 1137-1144 (Erica Head, Fisheries and Oceans Canada)	This aspect has now been mentioned and reference included.
649	50356	6	49	29	49	30	This statement would potentially benefit from further clarification. Is there correspondingly low confidence that there have been increases in frequency of outbreaks overall? Or is it the case that there has been an increase in overall frequency of outbreaks, but the outbreaks are not necessarily correlated with SST? (Katharine Mach, IPCC WGII TSU)	This text section has been clarified and complemented during the revision.
650	41723	6	49	33	49	48	Maybe this paragraph should appear in Ch30, the regional chapter. (Rui Zhang, Xiamen University)	We have revised and now emphasize general principles more in this whole section (6.3.2.), dealing with specific examples moved to a table. Specifically, we focus on long term range shifts and changes in community structure and seasonality of phytoplankton communities. We describe major changes: northward range shifts, changes in abundance beteween dinoflagellates and diatoms. Evidence from the North Atlantic is presented as a case study and described in a Box, with reference to Ch. 30.
651	39468	6	49	38	0	0	The idea of regime shift has become very important (even since AR4) - it now shapes how we seek to understand and explain marine change and what we look for - so I'd like the term defined and explained at the start of this paragraph, before the examples of shifts get described. (Sarah Cornell, Stockholm Resilience Centre)	Agreed. Regime shift has been explained in an earlier section (6.1.3.) of this chapter.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
652	37223	6	49	40	0	0	"Critical Thermal Boundary (CTB) found at 9-10oC beyond which such ecosystem shifts set in (Beaugrand et al.," Take out the "such". It implies that the same sort of ecosystem shifts will occur in the open ocean as occurred in the North Sea. There are not the same meroplankton that can proliferate in the deep ocean and benthic-pelagic coupling will have little effect. So, CTB – yes – but the switch in the deep ocean will be to an ecosystem different to the one that has emerged in the North Sea. (Erica Head, Fisheries and Oceans Canada)	The specific nature of the CTB in the North Sea has been emphasized.
653	37224	6	49	47	0	0	"possibly causing the significant increase observed in the numbers of large diatoms" This seems to contradict the previous paragraphs, and the finding that in the deep ocean smaller cells become more important with increasing temperatures. Because this seemed odd – I went to check the reference (Wiltshire et al. 2010). There was no specific Figure showing an overall increase in large diatoms and my reading of the article was that it was the invasive diatom species Coscinodiscus wailesii and Odontella sinensis and in the (indigenous) Guinardia delicatula that had increased in abundance. The suggestion was made that the latter two species may proliferate because they are highly silicified and therefore not easily grazed. I don't see that this is related to the CTB concept in the way that the text suggests. (Erica Head, Fisheries and Oceans Canada)	This text section has been clarified during the revision.
654	52565	6	49	47	0	0	Be careful - from 1962 to 1987 conditions remained cool and if anything got colder. Post 87/88 conditions rapidly warmed. Giving average warming implies a unidirectional shift. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We feel it is okay to report an average warming trend over a 50 year period - long enough to smooth out decadal variability and show long-term effects.
655	36869	6	49	50	50	4	Evidence of differential changes also exists for the same region. For instance, changes in SST and plankton composition and productivity in the southern Bay of Biscay were less marked in the areas influenced by seasonal upwelling (e.g. Valdés et al., 2007, Bode et al., 2009, 2011). Additional references: Bode, A., M. T. Alvarez-Ossorio, J. M. Cabanas, A. Miranda, and M. Varela. 2009. Recent trends in plankton and upwelling intensity off Galicia (NW Spain). Progress in Oceanography 83: 342-350; Bode, A., R. Anadón, X. A. G. Morán, E. Nogueira, E. Teira, and M. Varela. 2011. Decadal variability in chlorophyll and primary production off NW Spain. Climate Research 48: 293-305; Valdés, L., A. López-Urrutia, J. Cabal, M. Alvarez-Ossorio, A. Bode, A. Miranda, M. Cabanas, I. Huskin, R. Anadón, F. Alvarez-Marqués, M. Llope and N. Rodríguez. 2007. A decade of sampling in the Bay of Biscay: What are the zooplankton time series telling us? Progress in Oceanography 74: 98-114. (Antonio Bode, Instituto Espanol de Oceanografia)	This aspect has now been mentioned and references included.
656	47132	6	50	6	50	18	There is a recent paper by Simpson et al. (2011) (Simpson et al. (2011) Continental Shelf-Wide Response of a Fish Assemblage to Rapid Warming of the Sea. Current Biology 21, 1565-1570). This work investigated the response of the European Continental Shelf fish assembledge to rapid warming and found that species range shifts were not a major impact. Here is a direct quote from the paper: "Our analyses demonstrate that such distributional changes have been relatively benign on the European continental shelf during rapid warming of the sea over the last 30 years. Instead, there has been profound climate-driven reorganization of species abundance in established local communities over much of the shelf region, without spatial reorganization of species presence-absence. This result is important because local abundance changes in established fish communities have the greatest implications for both ecosystem function and societies dependent on marine natural resources. By contrast, over the timescale, studied changes in species ranges are arguably less important, because they result only from colonizations or extirpations that occur when species are necessarily scarce and below the abundances required for commercially viable exploitation. Thus, studies of distributional shifts can overlook ecologically and economically significant climate effects, except for rare examples of species range expansion coupled with large increases in abundance" (Vincent Saba, NOAA National Marine Fisheries Service)	Changes in distribution and abundance particularly on relatively small spatial scales (UK and Ireland) in the case of Simpson et al. 2011 have similar elements. E.g.: Changes in distribution result in a decrease in abundance in the southern range and an increase in abundance in the northern range (in the northern hemisphere). We now cite Simpson here, but this does not invalidate the statements that we have in this paragraph.
657	38540	6	50	11	50	12	I don't know what it means for warming to be effective for salmon. Also, there are better examples of temperature-related changes in fish distribution in the Northwest Atlantic. The majority of fish caught in the US National Marine Fisheries Service trawl surveys show a northward movement in response to warming since the 1960s (Nye et al. 2009, Lucey & Nye 2010), with some of the distribution shifts being correlated with the AMO (Nye et al. 2011). Lucey S, Nye J (2010) Shifting species assemblages in the Northeast US Continental Shelf Large Marine Ecosystem. Marine Ecology Progress Series 415:23-33 Nye JA, Joyce TM, Kwon Y-O, Link JS (2011) Silver hake tracks changes in Northwest Atlantic circulation. Nature Communications 2 Nye JA, Link JS, Hare JA, Overholtz WJ (2009) Changing spatial distribution of fish stocks in relation to climate and population size on the Northeast United States continental shelf. Marine Ecology Progress Series 393:111-129 (Andrew Pershing, University of Maine)	The effect on salmon is now clarified. Also, the suggested evidence of range shift and the supporting publications are now included in box 6-1.
658	37225	6	50	16	0	0	"Again, the cooling and freshening of the north-west Atlantic" This is misleading. The NW Atlantic cooled during the 1980s, but has warmed and become saltier since the early 1990s (Reid and Valdes, 2011). Indeed, between the early 1990s and the mid 2000s temperatures in the sub-polar gyre increased by about 1.5oC – similar to the NE Atlantic. So try: "Cooling and freshening during the late 1980-early 1990s had the opposite effect, with capelin and their predator Atlantic cod shifting farther south (Rose and O'Driscoll, 2002). Since the early 1990s temperatures have risen on the Newfoundland Shelf (Colbourne et al. 2011), but for reasons likely unrelated to climate, capelin and cod remain scarce throughout the region (DFO 2010, DFO 2011)." References Colbourne, E, J. Craig, C. Fitzpatrick, D. Senciall, P. Stead, and W. Bailey. 2011. An assessment of the physical oceanographic environment on the Newfoundland and Labrador Shelf during 2010. DFO Can. Sci. Advis. Sec. Res. Doc. 2011/089. iv + 31p DFO (2010) Assessment of capelin in SA2+Div. 3KL in 2010. CSAS Sci Advis Rep. 2010/090 DFO (2011) Recovery potential assessment for the Newfoundland and Labrador designatable unit (NAFO Divs 2GHJ, 3KLNO) of Atlantic cod (Gadus morhua) CSAS Sci Advis Rep. 2011/037 Reid, P.C. and L. Valdez. 2011. ICES status report on climate change in the North Atlantic. ICES Cooperative Research Report No. 310. 262 pp. (Erica Head, Fisheries and Oceans Canada)	We revised and clarified this section and integrated it into erlier text on the Northwest Atlantic.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
659	52566	6	50	44	0	0	(should read) In Ch 5. Considerable shifts in warm water species polewards have been observed. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	agreed and text has been modified
660	40434	6	50	44	50	47	Not true as a generalization - what about coral reefs? They're benthic! (Laura Petes, National Oceanic and Atmospheric Administration)	We think the statement that coral reefs are shaped by exposures to temperature extremes (e.g., coral bleaching under extreme high temperature) is still valid. This does not mean they are moving fast.
661	52567	6	50	46	0	0	(should read) English Channel (Hiscock et al. 2004 Aquatic Conservation, Hinz et al. 2011) (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	agreed, reference included
662	38636	6	51	5	51	9	Additional retrospective coral growth studies have also provided evidence of a recent decline in coral calcification rates. See also Tanzil JTL, BE Brown et al (2009) Decline in skeletal growth of the coral Porites lutea from the Anadaman Sea, South Thailand between 1984 and 2005. Coral Reefs doi: 10.1007/s00338-008-0457-5; Cantin NE, AL Cohen et al (2010). Ocean warming slows coral growth in the central Red Sea. Science 329: 322-325 and review paper Lough JM & TF Cooper (2011). New insights from coral growth band studies in an era of rapid environmental change. Earth-Science Reviews 108: 170-184. In addition, a recent study Cooper TF et al (2012) Growth of Western Australian corals in the Anthropocene. Science 335: 593-596 suggests that rates of SST warming are the primary drivers of recent observed changes in coral calcification rates. There is, as yet, no evidence from retrospective coral growth studies, that ocean acidification is affecting coral growth rates - the primary driver appears to be temperature changes (setbacks in growth due to bleaching events and likely also passing optimum threshold for calcification). (Janice Lough, Australian Institute of Marine Science)	This is additional supporting evidence, however, corals are a focus of ch. 5. and we refer to them and have a cross-chapter box.We included the recent Cooper et al. reference.
663	41724	6	51	5	51	25	Which chapter, 5 or 6, will has the coral reef content? (Rui Zhang, Xiamen University)	Corals are a focus of ch. 5., 6 and 30 with a cross-chapter box that we refer to.
664	50357	6	51	8	51	8	For this statement, the author team may wish to consider additionally specifying a summary term for agreement. (Katharine Mach, IPCC WGII TSU)	This statement has now been revised. An appropriate summary term for agreement is now included in the related to this topic.
665	38637	6	51	9	51	10	The regional and species specific nature of these 2 studies need to be mentioned. (Janice Lough, Australian Institute of Marine Science)	These two case studies are not described in the revised text.
666	38783	6	51	14	0	19	There are several papers that sustain this findings for temperate regions determined after long term sampling and observation. In nord Spain this is true for a 25 years long-term study that shows for a kelp a decreasing trend in some biological characteristics like reproductive output, size and final dissapaerance on sanpled locality. This changes has been related to change in the upwelling season with rise in the number of warm water during summer [Fernández, C. 2011. The retreat of large brown seaweeds on the north coast of Spain: the case of Saccorhiza polyschides. European Journal of Phycology, 46:352-360] A second recent paper shows a change in the annual cycle of cold Fucoids during the last 30 years, with changes in the associated fauna [Lamela, C., Fernández, C., Arrontes, J. y Anadón, R. 2012. Fucoids Assemblages on the North Coast of Spain: Past and Present (1977-2007). Botánica Marina, 55: 199–207] Recent personal observations show that except for Pelvetia canaliculata - the unique fucoid in high tide, the other species of Fucus or Ascophyllum nodosum practically dissapear (or maintain a very low bi0omss of regrowing plants) in the studied region. In my opinion match with the objetives of the point 6,3,2,1,2, becuase describe mechanisms related with temperature and upwelling changes at long term scale. Papers with similar results in this area (Nordwest Iberian Peninsula) demonstrate the change in coastal ecosystems [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; Díez, I. Muguerza, N. Santolaria, A. Ganzedo, U. Gorostiaga J.M.. 2012. Seaweed assemblage changes in the eastern Cantabrian Sea a nd their potential relationship to climate change. Estuarine, Coastal and Shelf Science 99: 108-120] (Ricardo Anadon, University of Oviedo)	We have included the Fernandez reference but have to focus on the general patterns, cannot delve to much into regional details.
667	50358	6	51	19	51	19	The relevant scenario or scenarios should be further clarified here--B1 or A1B? (Katharine Mach, IPCC WGII TSU)	This detail has been lost from the revised text.
668	41725	6	51	27	51	30	This paragraph is odd here. (Rui Zhang, Xiamen University)	This detail has been lost from the revised text.
669	36289	6	51	40	0	0	"Japanese Sea" should be changed to "Japanese waters" or "areas off Japan Islands". See above (Sanae Chiba, JAMSTEC)	Agreed and amended.
670	50359	6	51	41	51	41	It would be helpful to further clarify if attribution to temperature change regionally has occurred but not to climate change more broadly? (Katharine Mach, IPCC WGII TSU)	Yes, that is attributed to regional temperature change, the contribution of climate change remaining unidentified.
671	36290	6	51	41	51	44	" with food preferences… ". Identical to the text in Page 36, line 21~ (Sanae Chiba, JAMSTEC)	We edited the text to eliminate overlap between sections, this detail is now found in Table 6-6.
672	46503	6	51	43	51	44	This material has already been covered. On this at least all are in agreement (but with variations in the level of confidence) (Neville Smith, Bureau of Meteorology)	We edited the text to eliminate overlap between sections, this detail is now found in Table 6-6.
673	37226	6	51	54	0	0	“helgolandicus represent an unfavorable shift to less energy dense food particles for juvenile cod” I thought the problem with the species change is also partly because C. finmarchicus reproduces in the spring, so that it eggs and nauplii are available to larval cod, whereas C. helgolandicus reproduces later in the year, so that their eggs and nauplii are not there at the right time. This was recognized in the Beaugrand et al. paper, although not emphasized. So I would suggest the following change “helgolandicus represent an unfavorable shift to less energy dense food particles for juvenile cod and to a later timing for reproduction, such that Calanus eggs and nauplii are less abundant as food for newly hatched cod larvae.” (Erica Head, Fisheries and Oceans Canada)	Agreed and amended.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
674	37227	6	52	8	0	0	The reference “Pierre et al. 2005” is wrong. Pierre is the first name. The reference should be to “Fréon et al. 2005”. Also, in the reference list at the end of the Chapter, all of the names given for this reference are the first names! So “Pierre, F., C. Phillippe, S. Lynne and R. Claude” should be replaced by “Fréon, P., Cury, P., Shannon. L and C. Roy” Also, I didn’t see any suggestion in this reference to directed fishing of myctophids: but I can’t read Russian, so perhaps the other reference talks about it. It’s a pretty horrifying prospect. (Erica Head, Fisheries and Oceans Canada)	This comment refers to FOD p. 53 line 8… Names of authors corrected. Thanks for spotting this! However, this details has been lost during the revisions.
675	41726	6	52	15	0	0	Section 6.3.2.2.2. Most of the paragraph are talking about coastal issues (e.g. intertidal). (Rui Zhang, Xiamen University)	We have carefully selected benthic examples that support generalized conclusions with respect to temperature effects that would likely be applicable to shelf benthos as well..
676	52568	6	52	25	0	0	On the previous page work on intertidal species in chapter 5 is referred to, but these are extensive comments here? There is much evidence from the NE Atlantic of shifts in range of intertidal species (Mieskowska et al. 2005, 2006, 2008; Herbert et al, 2003; Helmuth et al, 2006 and changes in abundance (Polocanska et al 2008) with consequences for ecosystem functioning being by Hawkins et al, 2008, 2009. Should this be here too? (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We have carefully selected benthic examples that support generalized conclusions with respect to temperature effects that would likely be applicable to shelf benthos as well..
677	50360	6	52	29	52	29	The relevant scenario or scenarios should be further clarified here--B1 or A1B? (Katharine Mach, IPCC WGII TSU)	This detail has been lost from the revised text.
678	52569	6	52	34	0	0	ADD: The balance between net producing fucoid dominated shores and net importantly barnacle dominated shores change with latitude and wave exposure in the North Atlantic: fucoids dominate more northerly and sheltered shores (Hawkins & Hartnoll, 1983). This balance will be tilted by climate change with warmer and stormier conditions favouring barnacles over seaweeds (Hawkins et al. 2009). The balance between fucoids and barnacles is mediated by grazing - whole diversity and intensity of grazing is likely to increase. (Hawkins et al. 2009 and references therein? This might be better in chapter 5? (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We have carefully selected benthic examples that support generalized conclusions with respect to temperature effects that would likely be applicable to shelf benthos as well..
679	50361	6	52	34	52	49	For statements on these lines (34-35, 39, 49), the author team should additionally consider specifying summary terms for agreement. (Katharine Mach, IPCC WGII TSU)	This detail has been lost from the revised text.
680	46504	6	52	45	52	52	There seemed to be significant repetition of previous conclusions in 6.3.2 (eg anchovies v sardines; temperature and coral reefs. For the first time I am detecting looseness! (Neville Smith, Bureau of Meteorology)	We edited the text to eliminate overlap between sections.
681	36291	6	52	47	0	0	Not only "direct" effects of temperateture, evidence of indirect effects such as sea ice melt, staratification etc., are refered in this section. (Sanae Chiba, JAMSTEC)	These aspects have now been emphasized in the conclusions.
682	41727	6	53	1	0	0	Section 6.3.3. The overlapping of Ch5 and 6 on hypoxic condition and OMZ need to be solved. (Rui Zhang, Xiamen University)	The picture we provide on hypoxia developing in the marine realm is comprehensive, we have reduce coastal aspects to minimze potential overlap with chapter 5.
683	35967	6	53	14	0	0	additional reference for mesopelagic fish: Koslow et al. Mar Ecol Progr Ser 436: 207–218, 2011 (Frank Whitney, Institute of Ocean Sciences)	Reference has been added.
684	43024	6	53	15	53	15	Include Stramma et al., 2012, as reference for "enhanced capture by fisheries" (Cliff Law, NIWA)	This detail has been lost from the revised text.
685	43026	6	54	1	54	1	Interaction between multiple stressors should be put in one section (Cliff Law, NIWA)	We agree and this has been done, overlap is minimized, but reference to such section is needed.
686	38784	6	54	4	0	9	In my opinion one of the main drivers of change was the tempo in wich mechanisms act. The changes associated to season have great importance at local and regional scales; as example we use the upwelling both in California and the Northwest of Iberian Peninsula. In California [ALISON C . ILES, TARIK C. GOUHIER, BRUCE A. MENGE, JULIA S . STEWART, ALISON J . HAUPT and MARGARET C. LYNCH. 2012. Climate-driven trends and ecological implications of event-scale upwelling in the California Current System. Global Change Biology (2012) 18, 783–796, doi: 10.1111/j.1365-2486.2011.02567.xIn] demonstrate that with increasing upwelling the tempo and intensity were relevant to explain the dynamic of benthos. Probably is the same processes described by [Barth, J.A. Menge, B.A. Lubchenco, J. Chan, F. Bane, J.M. Kirincich, mA.R. mcManus, M.A. BNielsen, K.J. Pierce, S.D. Washburn, L. 2007. Delayed upwelling alter nearshore coastal ocean ecosystems in the norther California current. PNAS, 104: 3719-3724]. In north Iberia with a decreasing summer upwelling has been show c hanges in composition and primary production, that have implications for other trophic levels [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). F I Z F. PÉ REZ*, XOSE A . PADÍN, YOLANDA PAZOS, MIGUEL GILCOTO, MANUEL CABANAS, PAULA C. PARDO, Maria DOLORES DOVALand LUIS FARINA-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] (Ricardo Anadon, University of Oviedo)	The upwelling systems and their generic impacts are discussed elsewhere. The reference Iles et al has been included there (6.3.5.).
687	36120	6	54	4	54	13	Section 6.3.3.1 There are interaction between effects of anoxia linked to warming consequences and oxygen demand with potential changes in terrestrial nutrient inputs linked to global changes (Gross, 2009)" reference: Gross L. Metabolism predicts ecological respeonse to warming. PLOS Biol 2009;7(8). (Olivier Le Pape, Agrocampus Ouest)	The interactions between temperature and oxygen demand are dealt with and these papers have been cited in 6.3.6..
688	47299	6	54	5	54	7	This implies changes in circulation or mixing bringing more H2S to the surface, not necessarily a change in the rate of production. (James Christian, Government of Canada)	This treatment intends to outline the priniple relationships between warming and enhanced H2S levels in oxygen deficient areas..
689	43025	6	54	16	54	18	Fig 6.12 is too generalised; it fails to convey information on how organic matter is retained in upwelling aeas & leads to hypoxia. Also, stratification & reduced primary production in offshore waters are not connected with hypoxia (also the "reduced primary production" in the mid-water column is misleading) (Cliff Law, NIWA)	We have revised the figure accordingly.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
690	37228	6	54	21	0	0	Section 6.3.3.2. Microbial denitrification under hypoxia. This section needs a few more references to support its major points. (Erica Head, Fisheries and Oceans Canada)	We have added more references to support the assessment.
691	46505	6	54	36	0	0	This too seems to partly overlap prior discussions and conclusions. (Neville Smith, Bureau of Meteorology)	We have revised the text to reduce redundancy. Naturally conclusions build on previous text and may reiterate some details.
692	50362	6	54	38	54	39	For this statement, the author team should consider additionally specifying a summary term for agreement. (Katharine Mach, IPCC WGII TSU)	We have revised the use of uncertainty language.
693	36878	6	54	38	54	46	remove citations from the conclusions section. (all citations are appropriate for the preceding sections but not here) (Antonio Bode, Instituto Espanol de Oceanografia)	Citations were removed from all conclusions sections.
694	35968	6	54	46	0	0	perhaps add a reference: Diaz and Rosenberg 2008 Science 321, 926 DOI: 10.1126/science.1156401 (Frank Whitney, Institute of Ocean Sciences)	Citations were removed from all conclusions sections.
695	50363	6	54	49	0	0	Section 6.3.4. In this section, the author team might consider drawing further comparison between uatm and relevant climate/socio-economic scenarios where appropriate, for example as done on page 55, lines 18-20. (Katharine Mach, IPCC WGII TSU)	We have referred to the IPCC RCP scenarios whenever possible in this section using the annex from WGI.
696	43027	6	54	49	54	49	Interaction between multiple stressors should be put in one section (Cliff Law, NIWA)	We agree and this has been done, overlap is minimized, but reference to such section is needed.
697	35969	6	55	4	0	0	note earlier work on acidification, E.B. Powers 1922 THE PHYSIOLOGY OF THE RESPIRATION OF FISHES IN RELATION TO THE HYDROGEN ION CONCENTRATION OF THE MEDIUM. The Journal of General Physiology (Google on line to find the paper) and references within. (Frank Whitney, Institute of Ocean Sciences)	Thank you for this mentioning of an early paper on marine fish respiration in response to CO2 induced acidification.
698	43028	6	55	6	55	11	The discussion on the palaeorecord sheds no light here & is largely a repeat of previous information. (Cliff Law, NIWA)	This brief text puts the assessment of knowledge on anthropogenic ocean acidification into paleo-context. We therefore decided not to delete it.
699	50364	6	55	47	55	53	For the statements on lines 47-48 and 53-54, the author team should consider additionally specifying summary terms for agreement. (Katharine Mach, IPCC WGII TSU)	We have now only used confidence statements here.
700	40435	6	55	51	55	52	Recommend not using the word "fertilization," as readers might associate that with experimental additions of CO2 (as with "iron fertilization.") (Laura Petes, National Oceanic and Atmospheric Administration)	We deleted the word fertilisation to avoid the confusion
701	50365	6	56	24	56	24	For this statement, the author team should consider additionally specifying a summary term for agreement. (Katharine Mach, IPCC WGII TSU)	We have now only used confidence statements here. Again, most of these statements are in the conclusions section.
702	43029	6	56	43	56	45	Interaction between multiple stressors should be put in one section (Cliff Law, NIWA)	We agree and this has been done, overlap is minimized, but reference to such section is needed.
703	37229	6	56	45	0	0	“there is a strong OA-effect on calcification” Should say if this is a negative or positive effect (Erica Head, Fisheries and Oceans Canada)	This sentence has been lost during the revision, we have taken care that directions of effects are mentioned when details are discussed in the text.
704	52570	6	57	8	0	0	(should read) will their exhibit reduced calcification in response to OA.... (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We edited the text accordingly
705	43030	6	57	9	57	9	Include observation of decreasing pteropod shell flux in sediment traps in Southern Ocean waters (Roberts et al, 2011, Polar Biology, DOI 10.1007/s00300-011-1024-z (Cliff Law, NIWA)	This reference does not fit the context as it is abut the fate of shells in waters with various aragonite saturation elevels.
706	37230	6	57	21	0	0	“which led to apparent constraints on growth and reproduction of the copepod Acartia tonsa (Rossol et al., 2012). Otherwise, confidence is high that direct effects of OA on copepods will be small . . . ” I do not agree with this conclusion when it comes to oceanic copepods. OK, the work of Mayor et al. (2007) on copepod egg hatching, for example, was at a rather low pH, but the exposure time was short. I don’t think the evidence is strong enough to conclude that oceanic, ecologically significant species, such as C. finmarchicus, will not be affected by prolonged exposure to less extreme OA. So, I would say: “which led to apparent constraints on growth and reproduction of the copepod Acartia tonsa (Rossol et al., 2012). Direct effects of OA appear to be small on neritic copepods (medium confidence, medium evidence), but for larger, oceanic species (e.g. Calanus finmarchicus and C. glacialis) studies have been limited to measurements of egg production and hatching success rates at pH 6.95 (Mayor et al. 2007, Weydmann et al. 2012). This represents an extreme scenario for OA, but these experiments used short exposure periods (5 days) and the effects of prolonged exposure under less extreme OA conditions remain to be tested.” References Mayor, D.J., C. Matthews, K. Cook, A.F. Zuur and S. Hay. 2007. CO2-induced acidification affects hatching success in Calanus finmarchicus. Mar. Ecol. Prog. Ser. 350, 91-97 Weydmann, A, J.E. Søreide, S. Kwasniewski, S. Widdicombe. 2012. Influence of CO2-induced acidification on the reproduction of a key Arctic copepod Calanus glacialis. J. Exp. Mar. Biol. Ecol. 428, 39-42 (Erica Head, Fisheries and Oceans Canada)	We have reduced this text to discussing the influence of food quality. We have deleted any generalized statements on copepods, in light of the finding of species specific effects (Figure 6-9) and the lack of strong evidence.
707	37231	6	57	21	0	0	I could also add here that we have recently carried out some OA experiments with C finmarchicus, using a pH of 7.2, and we have found negative effects on egg production rates and egg-hatching, over a 5 day period. This is partly why I would not want to see such a definitive statement as was in the original text. I think the jury is still out. Acartia is a coastal species that probably encounters low pH conditions periodically. For truly oceanic species – I don’t think there are many studies (at least I couldn’t find many!) (Erica Head, Fisheries and Oceans Canada)	We have reduced this text to discussing the influence of food quality. We have deleted any generalized statements on copepods, in light of the finding of species specific effects (Figure 6-9) and the lack of strong evidence.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
708	47300	6	57	22	57	24	"confidence is high that direct effects of OA on copepods will be small" I don't see where this comes from. Copepods were barely mentioned to this point. This assertion may be true but I don't see how you can assign high confidence without reviewing any of the evidence. (James Christian, Government of Canada)	We have reduced this text to discussing the influence of food quality. We have deleted any generalized statements on copepods, in light of the finding of species specific effects (Figure 6 9) and the lack of strong evidence.
709	47133	6	57	24	57	25	Please consider adding this statement from new research that is currently in review: "Addtionally, new research suggests potential long-term impacts on the growth and rproduction of Antarctic krill (Euphausia superba) due to the effects of ocean acidity on krill metabolic physiology (Saba, G.K., Schofield, O., Torres, J.J., Hudson, E., and D.K. Steinberg. (In review, PLoS ONE). Increased feeding and nutrient excretion of adult Antarctic krill, Euphausia superba, exposed to enhanced carbon dioxide (CO2)) and the and the survival of larval krill (Kawaguchi et al., 2010). The Kawaguchi et al., 2011 listed in this report should be corrected to Kawaguchi et al. 2010. (Vincent Saba, NOAA National Marine Fisheries Service)	General principles at species levels have been discussed under 6.2.5., not in this community level assessment. The Kawaguchi work is included in Figure 6.9B, the Saba et al reference is now included under 6.2.5. and here, with respect to feed requirements.
710	38638	6	57	29	57	36	The findings of Fabricius et al (2011) regarding seagrasses being "winners" at a natural tropical coral reef CO2 seep site should be mentioned here. (Janice Lough, Australian Institute of Marine Science)	This study is heavily cited already but this is a relevant aspect and has been included.
711	50366	6	57	36	57	36	It would be preferable to indicate more precisely what is meant by "towards a mean pH of 7.8." (Katharine Mach, IPCC WGII TSU)	This formulation has been changed.
712	50367	6	58	1	58	4	For these statements, the author team should consider additionally specifying summary terms for agreement. (Katharine Mach, IPCC WGII TSU)	The wording has been changed, and the high variability in pH at these locations stated.
713	39469	6	58	19	0	0	The severity of effects in the actual world will have nothing to do with the 'applicable RCP [emission] scenario' - that affects the model world. Also, the world is not acting out any given scenario - formally, the scenario approach must not be taken as a forecast. This sentence needs to be much clearer - especially given the rest of the paragraph that explains that current models face validation and verification and benchmarking challenges because of empirical/observational data needs. Perhaps state 'Our understanding of the severity of future effects is based largely on coupled climate and biogeochemical ocean models, which show that effects depend on both the emission pathways (eg RCP scenarios) and the maximum CO2 levels reached [query: not equilibrium level?]...' (Sarah Cornell, Stockholm Resilience Centre)	This text section has been clarified during the revision.
714	50368	6	58	19	58	20	Is it possible to associate the effects with uatm levels to provide approximate indicators of future states? (Katharine Mach, IPCC WGII TSU)	The conclusion section states otherwise, this is not (yet) possible, except may be in case of coral reefs but there in relation to warming is the crucial driver.
715	52571	6	59	1	0	0	...competition, facilitation and food availability (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	This generality has been lost from the revised text.
716	52572	6	59	1	0	0	Positive interactions are also important (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	This generality has been lost from the revised text.
717	37522	6	59	2	59	3	...and thereby change the environment underlying specific communities that are dependent on these activities. (Elliott Hazen, National Oceanic and Atmospheric Association)	This generality has been lost from the revised text.
718	43031	6	59	21	59	21	Fig 6.13 is confusing & needs revising. It is unclear what the distinction is (in the legend also) between the upper & lower figure, & why these can't be incorporated into one figure. Use of the same size arrows is not informative. The vertical arrow labelled "Climate change including ocean acidification" is confusing; this implies that these processes are not in the upper figure when they are. Fishing is mentioned in the legend for the lower figure but is not indicated in the Figure. This is an important figure but it requires major revision. (Cliff Law, NIWA)	This figure (now 6-12) has been revised considering these comments.
719	50369	6	59	32	59	32	Where the word "affect" is used, it would be preferable to indicate if the nature of the effect is to increase, decrease, or both increase and decrease biodiversity (dependent on various factors)? (Katharine Mach, IPCC WGII TSU)	We have added that the direction and magnitude of the effects vary between biomes and refer to the approriate sections.
720	37523	6	59	36	59	37	Shifted geographical distribution of marine species, e.g., to higher latitude or deeper 37 water could cause changes in community composition and interactions (Simpson et al., 2011, Harley, 2011, Hazen et al. Predicted Habitat Shifts of Pacific Top Predators in a Changing Climate, in press, Nature Climate Change) (Elliott Hazen, National Oceanic and Atmospheric Association)	Reference has been added here and elsewhere.
721	52573	6	59	37	0	0	.....(Hawkins et al. 2009) MEPS relevant here Simpson ..... (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We added this references for the principles discussed although it is a rocky shore paper.
722	38785	6	59	42	0	49	In the same sense that previous comment some climate modifications must be understanded at a regional or local scale due to changes in species interactions [Menge, B.A. Blanchette, C.A. Raimondi, P.T. Freidenburg, T. Gaines, S.D. Lubchenco, J. Lohse, D. Hudson, G. Foley, M. Pamplin, J. 2004. Species interaction strenghth: testing model prediction along an upwelling gradient. Ecological Monographs, 74: 663-684], or due to changes in the physical forcings like curl upwelling [Rykaczewski, R.R. Checkley, D.M. 2008. Influence of ocean winds on the pelagic ecosystem in upwelling regions. PNAS, 105 (6): 1965-1970]. I suggest to incorporate this ideas in the draft. Probably in the future new discoveries in very different processes could demostrate this local or regional influence, that obviously were driving by global or Basin changes. (Ricardo Anadon, University of Oviedo)	This messaage is in our chapter in generic terms. For regional aspects please consult chapter 30.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
723	36874	6	59	42	59	49	Interaction between climate and food web effects may be the cause of large fluctuations in gelatinous plankton (e.g. jellyfish) populations. Climate effects include both warming (e.g. Molinero et al., 2005) and acidification (Richradson and Gibbons, 2008), while removal of top or competing predators were cited as examples of biological interaction (e.g. Richardson et al., 2009; Condon et al., 2012). Additional References: Condon, R. H., W. B. Graham, C. M. Duarte, K. A. Pitt, C. H. Lucas, S. H. D. Haddock, K. R. Sutherland, K. L. Robinson, N. A. Dawson, M. B. Decker, C. E. Mills, J. E. Purcell, A. Malej, H. Mianzan, S.-I. Uye, S. Gelcich, and L. P. Madin. 2012. Questioning the rise of gelatinous plankton in the World's Ocean. BioScience 62:160-169. Molinero, J. C., F. Ibanez, P. Nival, E. Buecher, and S. Souissi. 2005. The North Atlantic climate and the northwestern Mediterranean plankton variability. Limnol. Oceanogr. 50:1213-1220. Richardson, A. J., and M. Gibbons. 2008. Are jellyfish increasing in response to ocean acidification? Limnol. Oceanogr. 53:2040-2045. Richardson, A. J., A. Bakun, G. C. Hays, and M. J. Gibbons. 2009. The jellyfish joyride: causes, consequences and management responses to a more gelatinous future. Trends in Ecology and Evolution 24:312-322. (Antonio Bode, Instituto Espanol de Oceanografia)	Thank you, these aspects and references are relevant and have been included.
724	52574	6	59	47	0	0	Genner et al 2011 GCB (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Thank you, this reference is relevant and has been included.
725	37524	6	60	1	60	1	...any oceanic system that includes the complex links within and among ecosystems, (Elliott Hazen, National Oceanic and Atmospheric Association)	The text has been revised accordingly.
726	36292	6	60	6	0	0	Why is it "medium conficence " but "high confidence"? Seems contradiction to the description in Page 63, 3rd paragraph. (Sanae Chiba, JAMSTEC)	No, we think it is consistent to the conclusion that is made in FOD, p. 64 line 1-3. This detail has been lost here and moved to 6.5.
727	38639	6	60	11	60	14	I do not think there is any evidence, as yet, that ocean acidification has "impeded" calcification on tropical coral reefs. (Janice Lough, Australian Institute of Marine Science)	We have specifically referred to the combination of warming and acidification, with warming certainly being the main driver, at present. Evidenced for a potential (future) effect of OA on caclficiation comes from lab and field studies.
728	35970	6	60	23	0	0	sponge reef refs: Conway KW, Barrie JV, Austin WC, Luternauer JL (1991) Holocene sponge bioherms on the western Canadian continental shelf. Cont Shelf Res 11: 771-790; Whitney F, Conway KW, Thomson RE, Barrie JV, Krautter M, Mungov G (2005) Oceanographic habitat of sponge reefs on the western Canadian Continental Shelf. Cont Shelf Res 25: 211-226 (Frank Whitney, Institute of Ocean Sciences)	This text section has been shortened and clarified during the revision. Unfortunately, the limited knowledge of climate effects on sponge reefs does not allow us to expand on this aspect.
729	38786	6	61	8	0	10	I suggest to remenver the scales of change, tempo , frecuency of events, intensity, in general variability and not only changes in the direct parameters (temp, oxygen, nutrient, etc). In my feeling could explain better the observed changes, or the rates of changes, that only the lineal relationship used in many papers. (Ricardo Anadon, University of Oviedo)	We refer to the velocity and periodicity of changes in the respective table.
730	43032	6	61	18	61	18	Fig 6.14 - What is this figure trying to convey ? Its important to emphasise the differences in the scales of forcing & ecosystems but the figure appears to focus on the level of study carried out on each of these interactions, as the degree of confidence is based upon the methodological approach. Confidence in a particular result may be lower for a modelling study than for a laboratory study using the actual organisms with multiple variables, but it would be more useful to indicate the robustness of an observation. For example, a high level of confidence would apply where a number of models &/or experiments show the same trend or result, whereas a low confidence reflects where experiments and/or models have shown different results (as is the case for some of the examples in this figure). At present , by focussing on the degree of testing in a few publications, rather than the robustness of the result from a greater number of publications, the figure is misleading. (Cliff Law, NIWA)	We have converted this figure into a table and revised for clarity of the message.
731	38787	6	61	25	0	0	At this respect could clarify the panorama the long term study of Fernandez [Fernández, C. 2011. The retreat of large brown seaweeds on the north coast of Spain: the case of Saccorhiza polyschides. European Journal of Phycology, 46:352-360] about the decreasing and disappearance of this brown algae analysing their abundance, reproductive status, growth and size, annual cycle and survivorship curves. (Ricardo Anadon, University of Oviedo)	This study has been included in the thermal section 6.3.2. but here it does not quite fit as it has no evidence for the underlying mechanism.
732	39470	6	61	39	0	0	move this sentence further down into the paragraph - synergism and antagonism get defined in lines 46-47, so the logical place for the meta-analysis description is immediately after that. (Sarah Cornell, Stockholm Resilience Centre)	Agree. We edited the text as suggested
733	50370	6	61	43	61	44	For this statement, the author team should consider additionally specifying a summary term for agreement. (Katharine Mach, IPCC WGII TSU)	This detail has been lost from the revised text.
734	43033	6	61	53	61	53	"At the ocean basin scale, modeling experiments provide the most reliable suite of projections to date (Gruber, 2011)" - This is a reasonable comment but how is it reflected in Figure 6.14? (Cliff Law, NIWA)	Modeling is considered in the figure. The Gruber study is just an example considered in the text.
735	37525	6	62	19	62	20	...shrinking biogeographical ranges, changing phenologies and competitive... (Elliott Hazen, National Oceanic and Atmospheric Association)	Agree. We edited the text as suggested
736	48446	6	62	31	62	54	I think the findings of Rykaczewski and Dunne (2010). Enhanced nutrient supply to the California Current Ecosystem with global warming and increased stratification in an earth system model. Geophysical Research Letters 37 are highly relevant to this section. (Charles Stock, NOAA/Geophysical Fluid Dynamics Laboratory)	This paper has been incorporated when discussing nutrient suppy in upwelling systems.
737	46506	6	62	33	62	36	Direct overlap with 30.5.2. (Neville Smith, Bureau of Meteorology)	We talk about upwelling in generic terms and their relevance for the global ocean in various sections.
738	47134	6	62	39	62	41	But see (Rykaczewski, R. R. & Dunne, J. P. Enhanced nutrient supply to the California current ecosystem with global warming and increased stratification in an earth system model. Geophys. Res. Lett. 37, L21606 (2010)) where the GFDL ESM2.1 showed increased NPP with decreased upwelling in the California Current Ecosystem. (Vincent Saba, NOAA National Marine Fisheries Service)	We talk about the role of upwelling systems for nutrient supply using that reference. The focus here is not whether upwelling occurs. We have added that upwelling areas may increase nutrient content and productivity under enhanced stratification.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
739	42215	6	62	43	62	45	This statment is not correct. See the first and second comments above (X. Anton Alvarez-Salgado, CSIC Instituto de Investigaciones Marinas)	We have balanced the statement and included that in some areas a decrease in upwelling has been observed.
740	36872	6	62	43	62	54	The spatial heterogeneity of long term changes in upwelling systems must be acknowledged. For instance, there are evidences of differential effects of climate on upwelling intensity in marginal compared to central areas in the Canary-African upwelling, implying a reduced nutrient input in the former (e.g. Pérez et al., 2010) which do not match observed trends in phytoplankton biomass and primary production (e.g. Bode et al., 2011). Additional references: Bode, A., R. Anadón, X. A. G. Morán, E. Nogueira, E. Teira, and M. Varela. 2011. Decadal variability in chlorophyll and primary production off NW Spain. Climate Research 48:293-305. Pérez, F. F., X. A. Padin, Y. Pazos, M. Gilcoto, M. Cabanas, P. C. Pardo, M. D. Doval, and L. Farina-Bustos. 2010. Plankton response to weakening of the Iberian coastal upwelling. Global Change Biology 16:1258-1267. (Antonio Bode, Instituto Espanol de Oceanografia)	We have balanced the statement and included that in some areas a decrease in upwelling has been observed.
741	44198	6	62	43	62	54	Some contents overlap with those of chapter 30, which could be moved to the regional chapter, e.g., chapter 30? (RONGSHUO CAI, Third Institute of Oceanography)	We talk about upwelling in generic terms and their relevance for the global ocean in various sections.
742	38788	6	62	44	0	50	I suggest to comment that upwelling areas ar not units of functioning; this heterogeneity has crucial importance from the point of view of species and pelagic and benthic communities. At this respect the intensification of upwellings in a global scale is contradictory with information about some regional areas. In my experience (see references above) the observed changes in frequency and intensity has prometed important biological changes. Also in California, with intensifying upwelling changes in tempo has the capabilitie to transform benthic communities. And my final coment refers to coastal vs curl upwelling and their importance from the point of view of pelagic fishes (anchovy and sardine) as is how in the paper [Rykaczewski, R.R. Checkley, D.M. 2008. Influence of ocean winds on the pelagic ecosystem in upwelling regions. PNAS, 105 (6): 1965-1970] (Ricardo Anadon, University of Oviedo)	We talk about upwelling in generic terms and their relevance for the global ocean in various sections. The dynamics of the system is taken into account.
743	40436	6	62	50	62	51	What does it mean "the relationship between upwelling activity and SST is not signifiant?" Need to clarify. Upwelling brings col water to the surface, so there is a relationship between upwelling events and SST. (Laura Petes, National Oceanic and Atmospheric Administration)	This sentence has been deleted
744	47301	6	62	50	62	51	I don't understand what is meant by "the relationship between upwelling activity and sea surface temperature is not significant". In most contexts there is a clear and largely monotonic (inverse) relationship between upwelling and SST. (James Christian, Government of Canada)	This sentence has been deleted
745	37526	6	62	53	62	54	…or enhanced OA remains debated… (Elliott Hazen, National Oceanic and Atmospheric Association)	Agreed and amended.
746	47658	6	62	53	62	54	model analysis suggests that upwelling areas will increase nutrient content and productivity under enhanced stratification (Rykaczewski and Dunne, 2010). (John Dunne, NOAA/GFDL)	agreed, reference included
747	48276	6	63	0	0	0	The entire chapter needs a rewriting. The current method of including scientific terms that is not understandable by a non scientific audience needs a rethink (Malini Nair, Indian Institute of Science)	Comment not intended for Chapter 6 (Chapter 5!). Anyway this text section has been shortened and clarified during the revision.
748	50371	6	63	3	0	0	Section 6.3.7. Throughout this section, where the author team uses a summary term for evidence without corresponding assignment of a summary term for agreement, the author team should consider additionally indicating its evaluation of agreement. The TSU would be happy to discuss with the author team any questions it has regarding regarding evaluation of evidence and agreement within the framework of the uncertainties guidance for authors. (Katharine Mach, IPCC WGII TSU)	We have amended our use of the uncertainty language accordingly.
749	36879	6	63	5	64	13	remove citations from the conclusions section. (all citations are appropriate for the preceding sections but not here) (Antonio Bode, Instituto Espanol de Oceanografia)	This text section has been shortened and clarified during the revision. All references were removed.
750	46507	6	63	6	0	0	Seems that in a number of cases it was in part attributed (Neville Smith, Bureau of Meteorology)	This detail has been lost from the revised section.
751	37527	6	63	17	63	18	While temperature increases can be attributed to climate change effects, only a few cases allow clear attribution to another driver. (Elliott Hazen, National Oceanic and Atmospheric Association)	Agreed on the second half of sentence. Text has been modified
752	37232	6	63	20	0	0	“Robust evidence from various ocean regions demonstrate with high confidence that temperature governs the geography etc.” I don’t think it’s ALL temperature, since (for example) we are getting more arctic copepods in the NW Atlantic, arguably because increased temperatures are generating more ice-melt and increased arctic outflow. To put it another way - in the short/medium term plankton can only go where the currents take then. So, how about “Robust evidence from various ocean regions demonstrate with high confidence that temperature has a fundamental effect on the geography etc.” (Erica Head, Fisheries and Oceans Canada)	The text has been revised accordingly.
753	52575	6	63	20	0	0	There is excellent work on this going back to the 1900s - Orton, Southward, Hutchins, Thorson etc. this early work should be acknowledged. Helmuth et al. 2006 in AREES reviews a lot of this early work that we forget or never bother to read! (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	This text section has been shortened and clarified during the revision. All references were removed.
754	38640	6	63	49	63	51	De'ath et al (2009) only suggest warming temperatures as possible cause of calcification decline (see comment p. 51, line 5) and do not mention "productivity losses". (Janice Lough, Australian Institute of Marine Science)	moved elsewhere and replaced with "declines in performance"
755	46508	6	64	1	64	13	All this seems to have together well. No real issues with the bottom line conclusions. (Neville Smith, Bureau of Meteorology)	Thanks for your strong support.
756	52576	6	64	9	0	0	Genner et al. 2010 GCB (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	This text section has been shortened and clarified during the revision. All references were removed. This reference has been included elsewhere.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
757	37233	6	64	16	0	0	Section 6.4. Human activities in marine ecosystems: adaptation benefits and threats I wonder if there should be something about “plastics” in the ocean in this section.- or somewhere else in the Chapter, even if it’s not a climate change issue (Erica Head, Fisheries and Oceans Canada)	The section on ecosystem services has been shortened and clarified during the revision, leaving the plasticsc problem (together with other anthropogenic non-climate issues) out of the section´s scope.
758	46889	6	64	20	64	25	The 'ecosystem services' are the equivalent of 'ecosystem functions' in Chapter 5. Please cross reference to clarify that the same aspects are being discussed. (Genevra Harker, HarmonicQuay Ltd)	We will maintain the term services, as we found Chapter 5 uses both terms together (services being the consequence of the ecosystem functions). We have, however, included a crossreference to chapter 5 for coherence.
759	39471	6	64	20	64	33	Replace the MEA classification with the TEEB one, because it is better! The concept of 'supporting' services is theoretically problematic (and was pretty much impossible to distinguish from regulating services), so to improve the transdisciplinary treatment and development of the ecosystem services concept, TEEB frame them as underpinning 'habitat services', linked to (and dependent upon) habitat structure and process, rather than at the ecosystem function level. (Sarah Cornell, Stockholm Resilience Centre)	While we appreciate advantages of the TEEB classification, we have decided to keep the MEA classification, and particularly the supporting services category, to allow for a process-oriented rather than value or economics-oriented approach. Further, MEA classification is considered in other chapters (5), providing better cross-chapters coherence.
760	44434	6	64	35	0	0	There seems to be some mix up between the quantification of services and the value of them. I think it important to keep in mind the Millennium Ecosystem Assessment separation of; ecosystem function, service, human benefit and value. I.e. these must be kept separate and not mixed up. Clearly the quantification of services (even the identification of them!) is complicated, and even more so the valuation of the services. (Claire Armstrong, University of Tromso)	During the section´s revision we have significantly reduced the mentioning of valuation or quantification, and we have incorporated assessment instead (refering to identification and quantification of services). We went for a process oriented (climate change impacts) rather than economics oriented approach, reducing the monetary aspects of the ecosystem services and eliminating the mix up.
761	44435	6	64	44	0	0	Choice modeling should be included as one of the valuation methods, after contingent valuation. A possible reference (if this method is not mentioned in Farber et al reference) could be I.J. Bateman, R.T. carson, B. Day, M. Hanemann, N. Hanley, T. Hett. M. Jones-Lee, G Loomes, S. Morato, E. Ozdemiroglu, D.W. Pearce OBE, R. Sugden and J. Swanson: Economics Valuation with Stated Preference Techniques. Elgar, UK and USA, 2002. (Claire Armstrong, University of Tromso)	We checked the references and agree with the comment; however, mentioning of all valuation methods was eliminated during the revision and reduction of the section length.
762	44436	6	64	45	64	48	This section seems somewhat strange. On line 45 it is referred to “such an approach”, while there are many highly different approaches mentioned above. Furthermore you say that these methods insufficiently value some types of ecosystem services, such as cultural and supporting services. However, later on (p 71) you correctly allude to the fact that the value of supporting services cannot be treated in the same way as the other services, making this critique somewhat strange. If this sentence of the critique should remain in the text, it should at least be followed by a reference. I find it somewhat strange to put in the critique here, while there is hardly any mention of critique of general methods other places in the text. The critique is most important when concrete results are presented that need to be justified. Furthermore, the last sentence in this section is mixing up quantification of services and their values. (Claire Armstrong, University of Tromso)	This detail has been lost from the revised section.
763	38541	6	65	22	0	0	"approriated by sustainable fisheries"--I suspect you mean "higher than levels considered sustainable" (Andrew Pershing, University of Maine)	This detail has been lost from the revised section.
764	44437	6	65	26	65	27	Requires a reference? (Claire Armstrong, University of Tromso)	This detail has been lost from the revised section. The sentence was eliminated.
765	38789	6	65	27	0	28	Is interesting the price of fishing organisms as a key factor of the impact of geographical displacement and changing abundance of fish and cepahlopods. At this respect there are some references that show this changes in the demersal fishes [Poulard, J.C. Blanchard, F. 2005. The impact of climate change on the fish community structure of the eastern continental shelf of the Bay of Biscay. ICES Journal of Marine Science, 62(7): 1436-1443] or in general, for instance new species in the fishery, expansion of the fished area between others [Bañón, R. 2009.Variacions na diversidade e abundancia ictiolóxica en Galica por efecto do cambio climático. In: Pérez Muñuzurri, V. Fernández, M. Gómez, J.L (eds): Evidencias e impactos do cambio climático en Galicia. Xunta de Galiza. 391-401; Beare, D.J. Burns, F. Jones, E. Peach, K. Portilla, E. Greig, T. McKenzie, E. Reid, D. 2004. An increase in the abundance of anchovies and sardines in the north-western North Sea since 1995. Global Change Biology 10: 1209-1213; Sabatés, A. Martín, P. Lloret, J. Raya, V. 2006. Sea warming and fish distribution: the case of the small pelagic fish, Sardinella aurita, in the western Mediterranean. Global Change Biology 12: 2209-2219] (Ricardo Anadon, University of Oviedo)	Distribution changes are mostly treated in the context of global or regional fish production potential; however, we have included a mention of the impacts of distribution changes in fishing systems resulting from the changes in accessibility and fishing operations costs. Part of the suggested literature was incorporated.
766	50372	6	65	27	65	28	For this statement, the author team may wish to consider additionally specifying a summary term for agreement. (Katharine Mach, IPCC WGII TSU)	We have revised the use of uncertainty language.
767	35971	6	65	28	0	0	but probably safe to say climate variability explains the rise and fall of many fish populations? This variability, based on e.g. Temperature at least suggest future impacts of global warming (loss of southern salmon stocks; geographical shifts in distributions, etc.) (Frank Whitney, Institute of Ocean Sciences)	The original paragraph was eliminated from this section. The topic is now discussed earlier in the chapter, as capacities of acclimatization processes and their limits in shifting tolerances, as well as the long-term evolutionary consequences of such processes in relation to emission scenarios remain to be explored, and within fisheries as increased management challenges when overexploitation reduces the fish population´s capacities to buffer climate variability.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
768	50373	6	65	39	65	39	For this statement, it would be helpful to specify if the described interplay refers to effects observed to date or understanding of outcomes projected for the future. Additionally, the author team may wish to consider also specifying a summary term for agreement. (Katharine Mach, IPCC WGII TSU)	The interplay between non-climatic anthropogenic drivers and climate change is now discussed in paragraph 6 of 6.4.1, focused on the projected impacts of overexploitation on the population´s capacity to cope with climate variability. Also, a table (6-9) is now sumarizing this topic.
769	38542	6	65	42	0	0	You have "High confidence" that over-exploitation has a top down effect, but don't provide a reference. Regardless, I would strongly disagree with that statement. For example, Frank et al. (2005) (cited later in the chapter) is the most high profile paper documenting a supposed top-down impact from overfishing. However, several studies have countered their interpretation, and in fact, have proposed that bottom-up changes due to basin-scale climate forcing offer a better explanation for the observed changes. See Greene and Pershing (2007) and MERCINA (2012). Greene CH, Pershing AJ (2007) Climate drives sea change. Science 315:1084-1085 MERCINA (2012) Recent Arctic climate change and its remote forcing of Northwest Atlantic Shelf ecosystems. Oceanography. http://dx.doi.org/10.5670/oceanog.2012.64 (Andrew Pershing, University of Maine)	The paragraph was not meant to discriminate between stressors (top-down human related or bottom up climatic related), but to recognize them as interacting forcings. The entire section was rewritten, and fishing pressure is now treated as one of the stressors potentially interacting with climate variability and change, and we assigned medium confidence to the exacerbation of these synergies in the future, due to the limited existing evidence.
770	52577	6	65	52	0	0	...age and size structures of fished species (Genner et al. 2010) (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Correction incorporated in the new location of the paragraph (6.3.6)
771	46509	6	66	36	0	0	Would be good to see expressed as %GDP. (Neville Smith, Bureau of Meteorology)	The text has changed, and now the economic losses and costs of adaptation are mentioned globally in billions of US dollars. Since we are not comparing costs for different countries in this version, the use of GDP was considered unnecessary.
772	38790	6	66	51	0	0	Is an interesting aspect related to the accesibility of fishes to the artisanal fleets. Somo fishes scape to local peoples with potential economic losses. For insatance the Germo alalunga tuna migrate in the isoterm of 18 ºC. Inthe last decade this isotherm moves northward, and promotes that local and samll ship (the artisanal fleet of Nord Iberian Peninsula) do not gain access to this very important resource. I think is important to comment this cain of problems for local flets at less as potential cause of concern. (Ricardo Anadon, University of Oviedo)	This paragraph was modified, and the topic covered in a broader context. We mention that changes in fishing systems may result from the changes in accessibility and fishing costs.
773	35972	6	67	15	67	16	repetition of dietary protein sources not needed, already stated on previous page (Frank Whitney, Institute of Ocean Sciences)	The sentence was eliminated, thanks for stressing the redundancy.
774	50374	6	67	22	67	22	As possible, it would be preferable to indicate more precisely what is meant here by "significant." (Katharine Mach, IPCC WGII TSU)	This detail has been lost from the revised section. The sentence was eliminated.
775	46510	6	67	22	67	30	This is a good evidence-based summary (Neville Smith, Bureau of Meteorology)	Thanks for your strong support.
776	35973	6	67	26	0	0	habitat compression due to expanding hypoxia in equatorial (e.g. Stramma et al., 2011. Expansion of oxygen minimum zones may reduce available habitat for tropical pelagic fishes. Nature Climate Change. DOI: 10.1038/NCLIMATE1304) and subarctic Pacific waters (Koslow et al, 2011. Impact of declining intermediate-water oxygen on deepwater fishes in the California Current. Mar Ecol Progr Ser 436, 207-218) (Frank Whitney, Institute of Ocean Sciences)	This topic is treated in section 6.3.3., as one of the major effects of expanding OMZs being the habitat compression in pelagic fishes, and others. Also in the principle effects section as a process enhancing the foraging opportunities for predators, and altering accessibility for fisheries (section 6.3.5).
777	38543	6	67	38	67	40	My guess is this statement will be dated by the time the report is published, if it isn't already. I know of at least one commercial tidal power generator, and I'm sure that there are more in the pipeline. (Andrew Pershing, University of Maine)	This detail has been lost from the revised section. The sentence was eliminated.
778	47302	6	68	12	68	13	"for the last 800 kyr" prior to 1800 (James Christian, Government of Canada)	Agreed and amended.
779	35975	6	68	20	0	0	note that PIC fluxes strongly increased at Ocean Station P during El Nino events (Wong and Crawford 2002. DSR II 49, 5705-5715). Other papers (e.g. Wong et al 1998. Limnol Oceanogr 43, 1418-1426) also discuss changes in primary productivity in this region brought on by climate variability. (Frank Whitney, Institute of Ocean Sciences)	In the section (projection models), potential changes in PP due to climate change are treated globally, and insufficient understanding of the mechanisms is acknowledged. In other sections of the chapter (6.3.1) it is mentioned that climate variability can drive pronounced changes in primary productivity, with medium evidence and medium confidence, such as during the El Niño to La Niña transition in Equatorial Pacific, when enhanced nutrient and trace element supply are observed.
780	50375	6	68	25	68	25	"high confidence" -- This phrase, as calibrated uncertainty language, should be italicized. (Katharine Mach, IPCC WGII TSU)	Paragraph changed, but all calibrated language phrases have been italicized.
781	43034	6	68	52	68	53	On the contrary the Hamme et al 2010 observation indicates an ecosystem response to volcanic ash but no (certainly not rapid) feedback effect on ocean carbon as clearly stated in the following sentence. (Cliff Law, NIWA)	The section was rephrased and the feedback idea eliminated. It is now mentioned that there is observational support for a significant alteration of net primary production (NPP) in the ocean when environmental controls are altered due to natural perturbations, shifts in ocean currents, volcanic eruptions and enhanced iron supply as in high nitrate-low chlorophyll waters of the NE Pacific.
782	35974	6	68	53	0	0	2008 was the year Hamme et al suggests iron input from ash stimulated diatom growth. (Frank Whitney, Institute of Ocean Sciences)	This detail has been lost from the revised section, and there is no longer a reference to a particular year. Thanks for the correction.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
783	50376	6	69	4	69	36	Overlap between this material and earlier discussion in the chapter should be reduced, potentially with use of cross-references as appropriate. (Katharine Mach, IPCC WGII TSU)	Section length and overlap between sections were significantly reduced.
784	37234	6	69	5	0	0	"For example, there is medium confidence that increases in phytoplankton biomass detected in a long time series from 1986 until present may be a response to warming (driven by both climate variability and change) in the North Sea, in the NE Atlantic west of the British Isles and in the NW Atlantic sub-polar gyre (Johnson et al. 2012), whereas south of Iceland etc." Note the additions to the sentence. Reference Johnson, C., G. Harrison, E. Head, B. Casault, J. Spry, K. Pauley, H. Maass, M. Kennedy, C. Porter and I. Yashayaeva. 2012. Optical, chemical, and biological oceanographic conditions in the Maritimes Region in 2011. CSAS (In press) (Erica Head, Fisheries and Oceans Canada)	This detail has been lost from the revised section. The sentence was eliminated.
785	50377	6	69	16	69	16	"likely" -- If this term is being used per the uncertainties guidance for authors (reflecting a probabilistic basis for its assignment), it should be italicized. The author team should avoid casual usage of this reserved likelihood term. (Katharine Mach, IPCC WGII TSU)	Calibrated language terms were revised through the entire chapter.
786	47303	6	69	18	69	19	Inferences about phytoplankton response to ENSO contradict some of the earlier literature, and no reference is given. In 1991-92 nanoplankton declined under El Nino conditions but picoplankton showed ittle if any change (Bidigare and Ondrusek 1996 Deep-Sea es. II 43: 809). (James Christian, Government of Canada)	The entire section was eliminated. In other sections of the chapter ENSO is recognized to impact PP, but no specifics on phytoplankton fractions and their trends are mentioned.
787	35976	6	69	43	0	0	Also, any changes in remineralization depth brought about by interior ocean warming and expanding hypoxia (altering the depth distribution of migrating zoo and myctophids) will redistribute nutrients in shallower waters. Whitney 2011 (J. Oceanography DOI 10.1007/s10872-011-0051-2) observe no change in either winter or summer nutrient concentrations across the subarctic Pacific, despite increased upper ocean stratification. The hypothesis is that nutrient enrichment in the pycnocline is stablizing winter resupply. (Frank Whitney, Institute of Ocean Sciences)	The Climate regulation section was significantly reduced, and details on the biological pump were moved to other sections. This particular aspect was moved to the last paragraph of 6.1.1, including a mention of reduced nutrient supply partly being compensated for by river plumes (Signorini et al., 1999), or nutrient accumulation in the pycnocline as in the North Pacific (Whitney, 2011).
788	46511	6	69	48	0	0	Arguably a schematic of the biological pump is not critical for the chapter (Neville Smith, Bureau of Meteorology)	We are keeping the schematic representation of the biological pump since it is also used in other parts of the chapter, but we moved it to a previpous section where it is needed more, section 6.2.1., Ocean characteristics and climate sensitivities.
789	43035	6	69	48	69	48	The discussion in 6.4.1.2.1. Climate regulation and feedbacks, Fig 6.15 & Table 6.4 should appear earlier in this Chapter - for example, in 6.2.2.2. (Microbes – Link to Biogeochemical Processes) rather than here in Regulating Sevices; Feedbacks to climate is an important consideration that has considerable relevance to much of the earlier discussion, & more relevance than just an Ecosytem Service. On moving this section, it also needs to be expanded - the potential negative and positive feedbacks that may result from different processes deserves more discussion. (Cliff Law, NIWA)	We moved most of the discussion, the table and referenced figure to a pevious section: 6.2.1 Ocean characteristics and climate sensitivities. We have also included some discussion on the potential feedbacks, and the existing difficulties to project them.
790	46890	6	69	49	70	4	Figure 6-15, D and F are not explained. (Genevra Harker, HarmonicQuay Ltd)	Figure 6-15 was moved to section 6.2.1, and checked to ensure that every call within the figure has an explanation in the legend.
791	43036	6	70	7	70	7	Table 6.4. The impact of climate change (incluidng ocean acidification) on bacterial exoenzymes appears to have been overlooked. A general trend of increased activity for different enzyme has been recorded in the references listed, suggesting increased activity of the microbial loop with a reduction in vertical carbon export from the surface ocean with a potential positive feedback (Piontek J, Lunau M, Händel N, Borchard C, Wurst M, Engel A (2010) Acidification increases microbial polysaccharide degradation in the ocean. Biogeosciences 7:1615-1624; Grossart HP, Allgaier M, Passow U, Riebesell U (2006) Testing the effect of CO2 concentration on the dynamics of marine heterotrophic bacterioplankton. Limnol Oceanogr 51:1-11). (Cliff Law, NIWA)	These aspects have been added to the table. During revision, this section was reduced and table 6.4 was moved to section 6.2.1. with figure 6-15.
792	50378	6	70	14	70	18	For these statements, the author team should consider additionally specifying summary terms for agreement. (Katharine Mach, IPCC WGII TSU)	Calibrated language terms were revised through the entire chapter.
793	46512	6	70	23	0	0	This too has marginal value; some of it is probably covered in Chp 5 and Chp 30. (Neville Smith, Bureau of Meteorology)	We are keeping only a short mention within the section, and include a crossreference to chapters 5 and 30.
794	46773	6	70	23	71	35	The subsections covered here are also discussed under Chapter 5. Cross referencing? (Venugopalan Ittekkot, University of Bremen (retired))	We are keeping only a short mention within the section, and include a crossreference to chapters 5 and 30.
795	50379	6	70	25	70	26	The author team should cross-reference the working group 1 contribution to the 5th assessment report or the special report on extremes to support this statement, potentially with further qualification of wording used here. (Katharine Mach, IPCC WGII TSU)	We have cited the SREX in the paragraph, and revised accordingly.
796	46891	6	70	39	70	39	The impact on mangroves, marshes and wetlands is discussed in Chapter 5. Better to cross reference this rather than just say it is undetermined. (Genevra Harker, HarmonicQuay Ltd)	We have rephrased: These single or overlapping stressors may also decrease the ability of mangroves, marshes and wetlands to protect coastal regions from storms (WGII, Ch. 5).
797	46513	6	71	0	0	0	Certainly cannot be criticised for lack of comprehensiveness! (Neville Smith, Bureau of Meteorology)	Thanks for your support.
798	44438	6	71	5	0	0	Should perhaps rather be: "…visitors could choose to spend their recreational…" (Claire Armstrong, University of Tromso)	Correction made, wording adopted as suggested.
799	52578	6	71	35	0	0	Warming has led to enhanced diversity and temperate areas such as the British Isles as southern species of fish and invertebrates have moved polewards. This includes interesting and charismatic species such as sunfish (Mola mola). Is this worth mentioning? (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	This topic is treated in other sections of the chapter (such as 6.3.2 and at the end of 6.3.5)

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
800	39472	6	71	38	72	12	The first paragraph of this section will not be altered at all by using the TEEB classification of ecosystem services - simply replace habitat for supporting. The second paragraph presents an interesting challenge - in the sense that people are using the structure of an ecosystem, rather than its functions, transport certainly does belong in the habitat services category. Also, the text is clear that the habitat service underpins other kinds - the newly accessible resources of the Arctic are provisioning services. I suggest changing the first sentence (taking the word provision out removes one slightly confusing aspect): 'The human use of open waterways is a particular marine habitat service that is likely to change in specific, measurable ways ...' (Sarah Cornell, Stockholm Resilience Centre)	After revision, this section has been shortened and uncertainty language removed from the second paragraph. We kept the EMA classification for clarity and cross chapter coherence, but the specific paragraph has changed.
801	38791	6	71	47	0	48	I recommend to inbcorporate the the reference of hte UNEP that analyse the potential effects of Climate Change on tourism in many ways of action [UNWTO. 2008. Climate Change and Tourism – Responding to Global Challenges. ISBN 978-92-807-2886-6 (UNEP) 269 pp (http://www.unep.fr/shared/publications/pdf/WEBx0142xPA-ClimateChangeandTourismGlobalChallenges.pdf)] (Ricardo Anadon, University of Oviedo)	Agreed. The reference is included in the cultural sevices section.
802	52579	6	72	0	0	0	Opening up of the Northwest passage will also have a major influence on the biota of the North Atlantic. Many species have Pacific roots and entered the North Atlantic via a major episode of transarctic migration about 3.8 million years ago. This will happen again - speeded up by transport on ships hulls and in ballast water. This is worth commenting on somewhere in this chapter if not here. (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	We included a mention of the potential invasion of non indigenous species at the end of this section.
803	50380	6	72	2	72	2	"Very likely" -- If this term is being used per the uncertainties guidance for authors (reflecting a probabilistic basis for its assignment), it should be italicized. The author team should avoid casual usage of this reserved likelihood term. (Katharine Mach, IPCC WGII TSU)	This detail has been lost from the revised section.
804	46514	6	72	2	72	12	To Chp 30? (Neville Smith, Bureau of Meteorology)	crossreferenced
805	35977	6	72	15	0	0	I think ocean deoxygenation needs also to be mentioned in the concluding paragraph since it threatens habitat in many highly productive areas worldwide. (Frank Whitney, Institute of Ocean Sciences)	Ocean desoxygenation was included in the conclusions paragraph, with cross reference to other sections of the chapter.
806	36880	6	72	17	72	28	remove citations from the conclusions section. (all citations are appropriate for the preceding sections but not here) (Antonio Bode, Instituto Espanol de Oceanografia)	Agreed. All references were removed from the conclusions section.
807	39473	6	72	19	0	0	Fisher and Turner 2008 have proposed a clear distinction between assessing the service (which exists whether or not people avail themselves of it) and the human benefit (measurable, often in money terms) - their analysis has also influenced current ecosystem services application, as described in the TEEB and supporting documents. IPCC AR5 should refer to this more current and developed understanding rather than the MA 2005. (Sarah Cornell, Stockholm Resilience Centre)	While we appreciate advantages of the TEEB classification, we have decided to keep the MEA classification, MEA classification is considered in other chapters (5), providing better cross-chapter coherence.
808	50381	6	72	23	72	23	For this statement, the author team should consider additionally specifying a summary term for agreement. (Katharine Mach, IPCC WGII TSU)	Calibrated language terms were revised through the entire chapter.
809	39474	6	72	38	0	0	FAO 2003 is a very old reference. Better to give examples of current application, even if they are national (eg, UK's Defra 2008) or policy decisions (eg CBD COP VII, 2004 and more current reports) - or mention the significant institutional effort for developing guidance and global coverage - the IPBES. (Sarah Cornell, Stockholm Resilience Centre)	We kept the FAO reference as it was suggested by specialists, and it refers to the concept and global application, rather than specific, local cases.
810	38792	6	72	46	0	0	I suggest incorporate aquaculture and coastal harvesting to the idea, because shellfish and macroalgae will be affected in the future. (Ricardo Anadon, University of Oviedo)	This section was shortened after revision and this detail has been lost from the revised section.
811	35978	6	72	50	0	0	If OA is specifically mentioned, I'd suggest hypoxia and warming also be stated. This would link well with previous discussion. (Frank Whitney, Institute of Ocean Sciences)	This section was shortened after revision and this detail has been lost from the revised section.
812	47304	6	73	4	73	8	I think the term "adaptive management" should not be used because the definition used is not that of Walters and Hilborn, who coined the term (C. Walters, 1986. Adaptive Management of Renewable Resources. Blackburn Press.) (James Christian, Government of Canada)	Agreed. The text was reviesed and the concept removed from the section.
813	37531	6	73	7	73	8	"as these are early days" - not clear, "as we are in the early days of climate change, detection and attribution 8 currently have priority as a precondition for successful adaptive ecosystem management." Not sure I agree that we are in the "early days" of fisheries management given the percentage of stocks overfished. (Elliott Hazen, National Oceanic and Atmospheric Association)	This detail has been lost from the revised section. The sentence was eliminated.
814	35979	6	73	8	0	0	is it worth mentioning recent findings on loss of prey for herring and juvenile salmon in 2007 that may have led to disastrous returns of Fraser R sockeye in 2009 (papers by Beamish et al and Thomson et al. just published in Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science 4, 2012) and the ensuing large return in 2010 that may have been enhanced by 2008 volcanic iron inputs (Parsons and Whitney, Fish. Oceanogr. DOI: 10.1111/j.1365-2419.2012.00630.x)? I mention this to highlight the present difficulty in fisheries management, and suggest future climate fluctuations could exacerbate this problem. (Frank Whitney, Institute of Ocean Sciences)	Although this is a valuable contribution, this section was shortened during revision and the idea is centered on the challenge of management under climate change and use of spatial management, without mentioning specific examples.
815	52580	6	73	25	0	0	(Soto, 2011; Hawkins, 2012) Aquatic Conservation (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	Reference has been included.
816	41728	6	73	28	0	0	Section 6.4.2.2. I would like to provide a material named "Carbon sequestration by the microbial carbon pump" for your consideration. (Rui Zhang, Xiamen University)	The microbial carbon pump was not included in this section due to insufficient information to consider this process as a feasable geoingeneering technique.
817	46515	6	73	28	0	0	Why not simply assume the Expert Meeting report covers the background, which it does. (Neville Smith, Bureau of Meteorology)	We have reduced background information and focused on what is known about impact.
818	39023	6	73	28	74	32	This relatively brief section on geoengineering is really good. It has just the right amount of detail and the caveats given are on the mark. (George Somero , Stanford University)	Thanks for your strong support.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
819	46412	6	73	28	74	32	This section needs updating. The CDB reports 'Impacts of Climate-Related Geoengineering on biological diversity' has useful summaries of the impacts of geoengineering techniques that can be drawn on. This will be published by the CBD in late 2012 and has gone through 2 rounds of peer-review. The current version can be found at can be found on the CBD website at http://www.cbd.int/doc/meetings/sbstta/sbstta-16/information/sbstta-16-inf-28-en.pdf . (Chris Vivian, IMAREST)	We appreciate this early insight into the CBD report revised and have complemented and balanced the context of text and table accordingly. The report is now included in the reference base.
820	43037	6	73	30	73	38	6.4.2.2. Effects of Geoengineering Approaches - this paragraph needs revision, by starting with a description of the two types of geoengineering - CDR & SRA - with a couple of brief examples, followed by potential applications & legislation, then how they might influence ecosystems (Cliff Law, NIWA)	This comment is conflicting with comment 818. Nontheless, we have revised this section, focusing on potential impact.
821	46413	6	73	31	73	32	There are much earlier examples than Marchetti (1977) going back to 1877. See Table 1.1 on page 6 of US Government Accountability Office (2011) Technology Assessment: Climate Engineering. Technical status,future directions and potential responses. GAO-11-71. www.gao.gov/new.items/d1171.pdf for examples. (Chris Vivian, IMAREST)	We have removed all historical descriptions from the text and succinctly focus on impact.
822	46414	6	73	41	73	41	The term "chemical disposal in its various forms" is inaccurate and inappropriate. Many techniques do not involve the use of chemicals.. I suggest it be replaced by "these techniques in their various forms". (Chris Vivian, IMAREST)	This detail has been lost from the revised text.
823	40562	6	73	43	73	45	While it is fair to say that the mesoscale enrichment studies conducted to date have not been designed principally as geoengineering studies, this is not necessarily the case for all possible mesoscale enrichment studies. Hence it may be better to put this sentence in a contemporary context by saying "Note that the majority of mesoscale open ocean iron enrichment studies conducted to date (see Boyd et al., 2007) have not been designed as geoengineering studies, but have provided valuable insights into some of the unanticipated side effects of such medium scale (1000 km2) ocean manipulation." It might also be worth making reference here to the fact that ocean fertilization activities are now regulated under London Convention/London Protocol Resolutions LC-LP.1(2008), which disallows all ocean fertilization activities other then legitimate scientific research, and LC-LP.2(2010), which established the assessment framework to determine whether proposed ocean fertilization activities constitute legitimate scientific research (http://www.imo.org/blast/mainframemenu.asp?topic_id=1969). (David Santillo, Greenpeace Research Laboratories)	Due to space constraints we have reduced background information and focused on what is known about impact of the various approaches. This does not allow us to go into more detail about the present legislation which will be covered by WGIII (see IPCC expert meeting on geoengineering, report 2012).
824	50382	6	73	44	73	44	It would be helpful to clarify why the studies are not geo-engineering studies--because of their scale? (Katharine Mach, IPCC WGII TSU)	Scale is an issue and the goal of the investigation. However, this detail has been lost from the revised text.
825	46415	6	73	46	73	46	"CRD" should be "CDR". (Chris Vivian, IMAREST)	We have reworded the text, comment does not apply any more.
826	43038	6	73	51	73	51	Table 6.5 - SRA techniques - mention likely potential changes in precipitation; ocean fertilisation - mention potential change in nutrient distribution downstream of fertilisation sites and enhanced production of toxins (Silver et al, 2010, PNAS November 30, 2010 vol. 107 no. 48 20762-20767); (Cliff Law, NIWA)	This aspects have been mentioned and the reference included.
827	47305	6	74	3	74	3	"unless SRM is combined with CO2 emission reductions" or carbon dioxide removal (James Christian, Government of Canada)	agreed and amended
828	40563	6	74	8	74	9	In addition to concerns regarding impacts on land, the Expert Group report for the CBD SBSTTA on "IMPACTS OF CLIMATE-RELATED GEOENGINEERING ON BIOLOGICAL DIVERSITY" (UNEP/CBD/SBSTTA/16/INF/28, http://www.cbd.int/doc/meetings/sbstta/sbstta-16/information/sbstta-16-inf-28-en.pdf) noted that "While the theoretical chemistry of the processes of enhancing ocean alkalinity is relatively straightforward, the impacts on those processes on biodiversity (if the technique were to be deployed) are much more uncertain. In particular, the biological effects of temporarily enhanced Ca2+ ions and dissolved inorganic carbon are not adequately known". It may be worth including some reference to this. (David Santillo, Greenpeace Research Laboratories)	The text now cites the CBD document and includes these points.
829	43039	6	74	18	74	26	The impacts of hypoxia have been discussed previously in this chapter ; these sentences should be reduced & replaced with other potential effects of ocen fertilisation such as nutrient robbing & toxin production (see above). (Cliff Law, NIWA)	The text now cites the CBD document and includes these points.
830	40564	6	74	26	74	28	Recommend to replace the phrase "appear more benign" with "maybe less harmful" as the term benign (even if qualified) may be misinterpreted. It may also be worthwhile noting that, because of concerns over impacts, the direct disposal of CO2 into the water column or on the seabed has been prohibitted in some regions, most notably the North-East Atlantic region under the OSPAR Convention (OSPAR Decision 2007/1 to Prohibit the Storage of Carbon Dioxide Streams in the Water Column or on the Sea-bed, http://www.ucl.ac.uk/cclp/pdf/OSPAR2007-Annex-5.pdf). (David Santillo, Greenpeace Research Laboratories)	agreed and phrasing amended.Due to space constraints we have reduced background information and focused on what is known about impact of the various approaches. This does not allow us to go into more detail about the present legislation.
831	46416	6	74	26	74	28	That statement is one perspective but may well not be a generally accepted view. Fior example, one could argue that the proposal to deposit crop wastes in the deep ocean would be less damaging that the deposition of CO2 - see SE Strand & G Benford (2001) Ocean sequestration of crop residue carbon: Recycling fossil fuel carbon back to deep sediments. Environmental Science and technology 43, 1000-1007. (Chris Vivian, IMAREST)	This aspect is now included in text and table.
832	47306	6	74	27	74	27	I'm not sure the "deep-sea lake option" can be robustly inferred to be more benign than the more dispersed effect of fertilization. I had been under the impression that this approach had been more or less abandoned once the biological impacts began to be appreciated. (James Christian, Government of Canada)	This is a comparative statement, more benign has been replaced by less harmful. While the deep-lake option is locally detrimental, this comparative statement is meant to be valid on larger scales. This has now been added.
833	47307	6	74	29	74	29	"reduction of the warming trend would alleviate the synergistic effects of temperature with hypoxia and hypercapnia" This doesn't make sense to me: the temperature changes at these depths (>3000 m) will be very small. (James Christian, Government of Canada)	Agreed. This aspect has been lost from the revised text.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
834	43057	6	74	29	74	32	As shown in Griffith et al (2011) temperature change and acidification can be antagonistic and so acting to combat temperatrure change without also acting on ocean acidification could release acidification effects and create problems rather than simply solve them: Griffith, G.P., Fulton, E.A. and Richardson, A.J. 2011. Effects of fishing and acidification-related benthic mortality on the southeast Australian marine ecosystem. Global Change Biology 17:3058-3074 (Beth Fulton, CSIRO Marine and Atmospheric Research)	Agreed. This aspect has been lost from the revised text. (Temperature and hypercapnia act synergistically at thermal extremes but this does not apply here).
835	43040	6	74	30	74	32	Verification and validation of geoengineering is not mentioned here; is this covered elsewhere? (Cliff Law, NIWA)	The verification and validation is being dealt with by the WGIII report.
836	42216	6	74	39	74	54	Maybe it would be relevant to cite the work by Alvarez-Salgado et al. (Harmful Algae 7, 849–855, 2008), who demonstrated a significant relationship between the decline of the Iberian upwelling and the increase in the number of days per year that mussels cannot be extracted from the hanging ropes because of the occurrence of HABs. Note that 40% of the European and 20% of the world production of blue mussels came form the Iberian upwelling. (X. Anton Alvarez-Salgado, CSIC Instituto de Investigaciones Marinas)	Thanks for the comment and reference was checked, however, we decided to center this section on health issues for the human population, with special emphasis on HAB, cholera and ciguatera, without mentioning economic, aquacultural or fisheries impacts. Ecosystem services are mentioned in a generic way.
837	48447	6	74	41	74	41	While I am not familiar with the details of Edwards et al. (2006), I think that a more precise statement is needed here. From the title it looks like Edwards dealt only with the Northeast Atlantic. I would also caution that reliably attributing HAB changes at regional scales would likely require a very long time series - particularly in regions like the Northeast Atlantic that have prominent long time-scale modes of climate variability. (Charles Stock, NOAA/Geophysical Fluid Dynamics Laboratory)	Agreed. Revised section now emphasizes that the study by Edwards and Smith was carried out in the North Sea.
838	38544	6	74	46	0	0	You seem to be equating an increase in dinoflagellates with an increase in HABS. While some HAB species are dinoflagellates, not all dinoflagellates are harmful. (Andrew Pershing, University of Maine)	The revised section does not mention dinoflagellates but deals with HABs in generic terms.
839	40437	6	75	7	75	11	The wording of this paragraph suggests that there's high controversy, but for the most part, evidence suggests that climate variability and change will likely affect some marine diseases - both through impacts on host species (that affect their susceptibility to disease), as well as direct impacts on the pathogens that enable range shifts, higher virulence, etc. What is less certain is how changes in marine diseases will affect human health. Should clarify that this sub-section is focusing primarily on human health (as opposed to impacts of marine diseases on marine organismal health). (Laura Petes, National Oceanic and Atmospheric Administration)	Agreed. The respective writing was adjusted.
840	50383	6	75	28	75	28	For this statement, the author team should consider additionally specifying a summary term for agreement. (Katharine Mach, IPCC WGII TSU)	already included
841	46516	6	75	38	0	0	This is covered by WG 1 I think (Neville Smith, Bureau of Meteorology)	This section was removed from the chapter
842	47308	6	75	38	0	0	Section 6.4.2.4 There is a GHG as well as an ozone depletion component to changes in the circumpolar westerlies (e.g. Saenko et al 2005, Climate Dynamics 25: 415-426). (James Christian, Government of Canada)	This section was removed from the chapter
843	40438	6	75	40	75	53	This section should be one of the most important in the chapter but is currently weak. There are SO many other non-climatic stressors on oceans - what about pollution, nutirnet loading, overfishing, destructive fishing practices, etc.? Recommend a more balanced discussion as opposed to so much emphasis on one specific stressor (ozone change) that is not particularly relevant to marine resource management. (Laura Petes, National Oceanic and Atmospheric Administration)	This section was removed from the chapter as it is mainly a WGI issues as written. The impact of interacting factors is considered on several occasions in the other chapter sections.
844	52103	6	76	29	76	32	For the term "end-to-end model," the chapter team could also reference the entry in the report glossary. (Katharine Mach, IPCC WGII TSU)	We decided not to use the term "End-to-end model" because it is jargons used mainly in the modelling community. We directly described the range of modelling approaches instead. It is not a necessary term in the context of this chapter.
845	36870	6	76	47	77	28	All model projections listed consider only production derived from nutrients provided by mixing of surface and deep waters. However, there are evidences of an increase of production derived from atmospheric N-fixation in tropical and subtropical waters, favoured by increasing stratification and reduced nutrient inputs from mixing (e.g. Moore et al., 2009, Boyd et al., 2010). Recent studies suggest that nitrogen fixation has been underestimated by model and field sampling (Mohr et al., 2010, Mulholland et al., 2012) but the extent of this understimation is not yet known (Luo et al., 2012). (Antonio Bode, Instituto Espanol de Oceanografia)	The suggested uncertainty in global NPP projections is now incorporated in section 6.5.1. This does not affect our assessment of confidence in projections of ocean primary production.
846	36871	6	76	47	77	28	Additional references: Luo, Y.-W., S. C. Doney, L. A. Anderson, M. Benavides, A. Bode, S. Bonnet, K. H. Boström, D. Böttjer, D. G. Capone, E. J. Carpenter, Y. L. Chen, M. J. Church, J. E. Dore, L. I. Falcón, A. Fernández, R. A. Foster, K. Furuya, F. Gómez, K. Gundersen, A. M. Hynes, D. M. Karl, S. Kitajima, R. J. Langlois, J. LaRoche, R. M. Letelier, E. Marañón, D. J. McGillicuddy Jr., P. H. Moisander, C. M. Moore, B. Mouriño-Carballido, M. R. Mulholland, J. A. Needoba, K. M. Orcutt, A. J. Poulton, P. Raimbault, A. P. Rees, L. Riemann, T. Shiozaki, A. Subramaniam, T. Tyrrell, K. A. Turk-Kubo, M. Varela, T. A. Villareal, E. A. Webb, A. E. White, J. Wu, and J. P. Zehr. 2012. Database of diazotrophs in global ocean: abundances, biomass and nitrogen fixation rates. Earth Syst. Sci. Data Discuss. 5:47-106 Mohr, W., T. Großkopf, D. W. R. Wallace, and J. LaRoche. 2010. Methodological Underestimation of Oceanic Nitrogen Fixation Rates. PLoS ONE 5 doi:10.1371/journal.pone.0012583; Moore, C. M., M. M. Mills, E. P. Achterberg, R. J. Geider, J. LaRoche, M. I. Lucas, E. L. McDonagh, X. Pan, A. J. Poulton, M. J. A. Rijkenberg, D. J. Suggett, S. J. Ussher, and E. M. S. Woodward. 2009. Large-scale distribution of Atlantic nitrogen fixation controlled by iron availability. Nature Geoscience 2:867-871. Mulholland, M. R., P. W. Bernhardt, J. L. Blanco-Garcia, A. Mannino, K. Hyde, E. Mondragon, K. Turk, P. H. Moisander, and J. P. Zehr. 2012. Rates of dinitrogen fixation and the abundance of diazotrophs in North American coastal waters between Cape Hatteras and Georges Bank. Limnol. Oceanogr. 57:1067-1083. (Antonio Bode, Instituto Espanol de Oceanografia)	We added these references to the text.
847	50384	6	76	49	76	51	The author team may wish to consider redundancy in this statement with earlier material in the chapter. (Katharine Mach, IPCC WGII TSU)	We deleted this redundant description.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
848	38793	6	77	1	0	0	I suggest some cautionary mention to the increase of NPP due to differences between areas, very important question for analysisn impacts of Climate change. Also becase the reference for NPP estimation and modelling are sustained in empirical methodologies (mostly C14 and oxygen) under discussion. This methods have not blacks and were afected by size of incubation bottles or cascade effects during experiments mostly in oligotrophic regions ; ie. the very recent paper of Huete-Ortega [Huete-Ortega, M. Cermeño, P. Calvo-Díaz, A. Marañón, E. 2011. Isometric size-scaling of metabolic rate and the size abundance distribution of phytoplankton. Proceedings Royal Society of London B, doi: 10.1098/rspb.2011.2257: 1-9]. Also new discoveries like the under ice phytoplankton blooms introduce some uncertainties in the actual projections. (Ricardo Anadon, University of Oviedo)	The uncertainty of NPP projections resulted from potential uncertainty of their observations is now noted. Also, the text now refers to 6.1.3 for general uncertainties about NPP observations
849	38794	6	77	13	0	14	I think the periods must be 2090 to 2099 and 1860-1869 (see figure) (Ricardo Anadon, University of Oviedo)	The caption refers to 2080 to 2099 relative to 1870 to 1889. This has been checked and confirmed.
850	35980	6	77	16	0	0	I'd suggest with high confidence that NPP will change with or without golbal warming due to natural variability. The issue is by how much and where. Perhaps the statement should be that patterns of NPP will change with global warming (e.g. Subtropical fronts may move northward, (Polovino et al 2011 ICES Journal of Marine Science; doi:10.1093/icesjms/fsq198), Arctic NPP should increase with reduced ice cover, etc) but then qualify as you have done to state that the net effects of change are uncertain. (Frank Whitney, Institute of Ocean Sciences)	We have now noted "Long-term average" to avoid confusion with natural climate variability. We have also cited Polovina et al. 2011.
851	48448	6	77	16	77	19	I generally agree with this assessment. The statements in the Executive Summary should be modified to be consistent with it. (Charles Stock, NOAA/Geophysical Fluid Dynamics Laboratory)	The ES is now consisten with the assessment of ocean primary production (6.5.1).
852	35981	6	77	16	77	28	Models will fail until we better understand the impacts of warming, acidification and deoxygenation on nutrient recycling. A very telling summary was presented at the recent Goldschmidt Conference in a plenary on past ocean extinctions by Lee Kump where he stated "Contrary to the initial impression of a total collapse of the ocean's biological productivity, he said the record seems to indicate that the biological pump of carbon to the deep ocean was shut down. This led to a homogenization and mixing of the ocean, but did not necessarily bring an end to biological productivity at the surface. The Cretaceous-Paleogene extinction affected most organisms, but not all, and research currently in progress suggests a decline in the depth of the remineralization process from 600 to 100 metres. Modelling shows that the ocean differential "is essentially destroyed" on a scale of 5,000 years, Dr. Kump said. "But as it turns out, the productivity of that surface ocean has not been adversely affected. In fact, if you think about it, productivity is actually increasing in this ocean because the recycling of nutrients is happening closer to the surface." In my opinion, we are seeing a weak change of this type in the past 50 y in the subarctic Pacific (Whitney 2011). (Frank Whitney, Institute of Ocean Sciences)	The potentially imcomplete knowledge about the effects of ocean warming, deoxygenation and acidification of projection of NPP is now noted. Our current agreement/confidence assessment for NPP projections has accounted for this.
853	43041	6	77	39	77	39	Figure 6.17 title indicates a shift of 23 m whereas this should be in units of km (Cliff Law, NIWA)	This is now corrected.
854	43042	6	77	39	77	39	The text indicates a shift of "around 50m/decade" whereas Fig 6.17 indicates its 23km/decade (Cliff Law, NIWA)	Figure 6.17 panel B has been removed in the SOD.
855	35982	6	77	40	77	41	"Based on temperature, the rate of range shifts is projected to be three times higher for pelagic than for demersal fishes." The expansion of hypoxic waters, however, may have a greater impact on demersal fishes (Koslow et al 2011). (Frank Whitney, Institute of Ocean Sciences)	The potentially greater impact of expansion of hypoxic waters on demersal species is now noted.
856	37235	6	77	43	0	0	Line 43 Should "sub-Arctic" be "sub-polar"? Also I think this statement is a bit misleading. Sub-Arctic (or sub-polar) regions might be expected to have extinctions, but the number of invading species is likely to exceed the number of extinctions. So should this statement be: "As a result, high latitude regions (the Arctic and Southern Ocean) are projected to have high rates of species invasions, while sub-Arctic (and sub-Antarctic) regions are likely to have both species invasions and extinctions (or extirpations), and tropical regions and semi-enclosed seas are expected to have high rates of local extinctions." (Erica Head, Fisheries and Oceans Canada)	Agreed. This is clarified in the SOD by saying that intermediate latitude regions are expected to have both invasion and local extinction.
857	37241	6	77	45	0	0	Fig. 6-17 In panel B on the RHS "Shift in depth centroid" the y-axis is negative in both directions from 0. I don't think this is right. (Erica Head, Fisheries and Oceans Canada)	Figure 6.17 panel B has been removed in the SOD.
858	47135	6	78	7	78	9	Again, please refer to and discuss contrasting results from Simpson et al. (2011) for the European Shelf. See above. (Vincent Saba, NOAA National Marine Fisheries Service)	The examples of projections in the European Seas are not included in the SOD. Also, a recent analysis contrasted projections with results from Simpson et al. 2011 and showed general agreement on the trends of change between observations and projections. This is now noted in the SOD.
859	37532	6	78	14	78	14	New text: A multi-species modeling approach in the Northeast Pacific predicted that habitat for top predators was likely to remain strong in the California current yet could shift north for the transition zone under SRES A2 (Hazen et al. 2012). Furthermore, some species were predicted to gain pelagic habitat while others lost habitat suggesting a varied response to environmental change in this region. With any of these approaches it is important to differentiate between species and population level responses to adaptively manage ocean ecosystems. (Elliott Hazen, National Oceanic and Atmospheric Association)	The potential differences in the responses at species and populations are noted in the text. Region-specific assessments are dealt with by Ch. 30. Hazen et al. 2012 is now cited.
860	38641	6	78	23	78	37	Following references relevant to modelling impacts on coral reefs: 1) Teneva L et al (2012) Predicting coral bleaching hotspots: the role of regional variability in thermal stress and potential adaptation rates. Coral Reefs 31: 1-12, 2) Meissner KJ et al (2012) Large-scale stress factors affecting coral reefs: open ocean sea surface temperature and surface water aragonite saturation over the next 400 years. Coral Reefs doi:10.1007/s00338-011-0866-8 (Janice Lough, Australian Institute of Marine Science)	Information from these two references is now included in the SOD.
861	35983	6	78	53	0	0	...except where hypoxia prohibits deeper movement. In regions where low oxygen waters are exanding (e.g. equatorial waters, upwelling regions, the subarctic Pacific and coastal waters experiencing eutrophication), biota may be forced into less favorable shallower habitat. (Frank Whitney, Institute of Ocean Sciences)	This is now noted in the SOD.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
862	35984	6	79	26	0	0	...catches...are (Frank Whitney, Institute of Ocean Sciences)	Corrected in SOD.
863	35454	6	79	27	79	27	To add after of (Lehodey et al., 2011) the following comment: A study on fish populations in the Portuguese coast under A2 and B2 scenarios concluded that new commercial opportunities may emerge for commercial fisheries, since new species could move to these grounds (Vinagre et al., 2011). (M. Dolores Garza-Gil, University of Vigo)	We do not include all the examples of regional case studies as the focus of this chapter which has a focus on global/broad-scale patterns. Regional examples are dealt with by chapter 30.
864	35985	6	79	27	79	40	although their results do not arise from models, perhaps include McClatchie et al 2010 and Koslow et al 2011 who describe the impacts of oxygen loss on midwater fishes along the California coast. Unpublished results presented at symposia show similar impacts along the BC and N Japanese coast, thus I feel their findings identify an issue common to the subarctic Pacific. (Frank Whitney, Institute of Ocean Sciences)	The information and references are incorporated in section 6.3.3 now.
865	43058	6	79	40	0	0	Due to gape limitation in feeding in many marine species, changed size distributions also has trophic and mortality potential consequences. (Beth Fulton, CSIRO Marine and Atmospheric Research)	This is now added to the SOD.
866	37236	6	80	19	0	0	“decrease by 2035 and 2100 relative to 2000-2100” should be “decrease by 2035 and 2100 relative to 2000-2010” (Erica Head, Fisheries and Oceans Canada)	This is now revised in the SOD.
867	47309	6	80	19	80	19	"decrease by 2035 and 2100 relative to 2000-2100" ??? something wrong here (James Christian, Government of Canada)	This is now revised in the SOD.
868	36873	6	80	45	80	48	a cautionary comment on the lack of N-fixation in the models will be appropriate here (see earlier comment to page 76, line 47 to page 77, line 28) (Antonio Bode, Instituto Espanol de Oceanografia)	See response to #845
869	35986	6	80	52	0	0	again, qualify the movement of species into deeper water - e.g. except where hypoxia restricts habitat shifts. Many of the highly productive waters in world oceans are associated with OMZs. (Frank Whitney, Institute of Ocean Sciences)	This is now noted in the SOD.
870	38795	6	81	6	0	10	I suggest to incorporate some mention to the inhability to include new and unpredictable components (unknows). Some authors tell about ecological surprises [DOAK, D.F. JAMES A. ESTES, BENJAMIN S. HALPERN, UTE JACOB, DAVID R. LINDBERG, JAMES LOVVORN, DANIEL H. MONSON, M. TIMOTHY TINKER, TERRIE M. WILLIAMS, J. TIMOTHY WOOTTON, IAN CARROLL, MARK EMMERSON, FIORENZA MICHELI, AND MARK NOVAK. 2008. Understanding and predicting ecological dynamics: are mayor surprises inevitable? Ecology, 89(4): 952-961; Williams, J. W. Jackson, S. T. 2007. Novel climates, no-analog communities, and ecological surprises. Frontiers in Ecology and the Environment, 5(9): 475-482; Lindenmayer, D.B. Likens, G.E. Krebs, C.J. Hobbs, R.J. 2010. Improved probability of detection of ecological “surprises”. PNAS 107 (51): 21957-21962]. As example I incorporate a pharse of the Doak et al paper "Although most work on this subject involves statistical aspects of data analysis and modeling, the frequency and nature of ecological surprises imply that uncertainty cannot be easily tamed through improved analytical procedures". I think is importanto to incorporate this idea. In relation with the idea also I suggest to make more enphasis about the difficulties to appropiately parametrize the non linial responses of ecological interactions; tipping points probably are not well detected until now. (Ricardo Anadon, University of Oviedo)	We include a discussion on difficulties in modelling and making projections for complex ecological systems, and the possibility of "high impact low probability" changes (6.5.3 end of last paragraph). The suggested references are now cited in that section.
871	36881	6	81	6	81	22	remove citations from the conclusions section. (all citations are appropriate for the preceding sections but not here) (Antonio Bode, Instituto Espanol de Oceanografia)	The text has been revised accordingly. References were removed.
872	47310	6	81	25	0	0	Section 6.6 I do not understand the point of the abbreviations/acronyms (bold) that are coined here, and in most cases never used again (e.g., BG, GR OAE ...) (James Christian, Government of Canada)	For clear reference we have developed a consistent code that is found in the text (summary section) and in the figure. The latter may have bee overlooked by the referee.
873	50385	6	81	25	0	0	Section 6.6. In some places throughout this section, where a summary term for evidence is provided without a corresponding assignment of a summary term for agreement, the author team should consider additionally indicating its evaluation of agreement. (Katharine Mach, IPCC WGII TSU)	We have more systematically used the uncertainty language now..
874	36882	6	81	27	85	15	Very well written and summarized. No citations here. This section is an example of format for all other "conclusions" sections in the text. (Antonio Bode, Instituto Espanol de Oceanografia)	Thank you. We have done our best to unify the format of conclusions sections in the text.
875	43043	6	81	32	81	32	Fig 16.8 - definitely separate specific species examples from general trends (Cliff Law, NIWA)	Agreed. We have separated specific species examples from general trends.
876	46517	6	82	35	0	0	I accepted the attribution to warming, but the attribution to anthropogenic CC warming was less clear, particularly with warming being quite uneven (Neville Smith, Bureau of Meteorology)	Agreed, the differentiation between warming due to climate variability and anthropogenic warming is an issue. This is a discussion to be led by WGI where such evidence is to be assessed.
877	49059	6	83	18	83	28	The logic in the paragraph seems hard to understand and we suggest a clarification and explanation; Line 20-25 suggest an ongoing increase in gNPP (Global Net Primary Production); "There is medium confidence based on limited evidence from these relatively few offshore time series sites that there has been a small but significant increase in global NPP (gNPP) over the last two decades, but confidence is low that this increase may be linked to climate change. At high latitudes, there is medium confidence based on limited evidence from satellite images that an increase in the number of sea-ice free days is resulting in higher rates of hNPP (attributable to climate change with high confidence, 6.3.1.)". The following sentence (line 25-26) seems to be non-consistent; the first part "Such trends are projected to be strengthened with further warming" creates an expectation for further increase in gNPP but continues with the opposite; " and there is medium agreement between models that global NPP will decrease by 2100 relative to now under the SRES A1 and A2 scenarios..", (Oyvind Christophersen, Climate and Pollution Agency)	Agreed, the contradictory sections of this paragraph have been amended. Present observations are now more clearly distinguished from model projections ad their uncertainties.
878	40439	6	83	24	0	0	What is "hNPP?" (Laura Petes, National Oceanic and Atmospheric Administration)	It is presently explained in Fig. 6.18 (high latitude net primary production). We now also explain it on first mention in the text.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
879	46518	6	83	24	83	25	Again I am struggling with whether this means uniquely attributable or in part. Chapter 18 also warns against testing attribution using the same data that we used to create the hypothesis in the first place. This is often done in this Chapter. (Neville Smith, Bureau of Meteorology)	The sentence: "Chapter 18 also warns against testing attribution using the same data that we used to create the hypothesis in the first place" would require explanation with examples. We assume that the reviewer thinks that whenever we use the term climate change we mean anthropogenic climate change? This is not the case as we are not able to distinguish between the two for each example, however, we know there is a large anthropogenic omponent in onging change (6.1.1.). We discuss observations and mechanisms providing cause and effect which support attribution. We build on evidence with respect to climate change that is discussed by WGI.
880	35987	6	84	1	84	21	I feel the loss of deep habitat and biomass of midwater fishes off California due to hypoxia is worth mentioning. Koslow et al (2011) predict substantial habitat losses in future if patterns of the past couple of decades persisit. (Frank Whitney, Institute of Ocean Sciences)	agreed and amended
881	36293	6	84	5	84	6	"Japanese Sea" Again, It should be changed to "Japanese waters" or "areas off Japan Islands". See above. It would not be the case If there is some "political agreement" about the nomencleture. (Sanae Chiba, JAMSTEC)	agreed and amended, see 550
882	37237	6	84	24	0	0	“individual phenomena in some species of seabirds (reduced abundance, species shifts, changes in phenology)” Note the suggested addition (Erica Head, Fisheries and Oceans Canada)	agreed and amended
883	35988	6	84	43	0	0	A substantial uncertainty pertaining to ocean oxygen content (and acidity) is the stability of gas hydrates along continental margins. Westbrook et al 2009 GEOPHYSICAL RESEARCH LETTERS, VOL. 36, L15608, doi:10.1029/2009GL039191, describe a seep field that may be more activate because of a 1 C warming off West Spitsbergen. I believe ocean models are not yet considering this an issue, yet it is considered one mechanism by which oceans have become anoxic in the geological past (Heydari et al, Palaeogeography, Palaeoclimatology, Palaeoecology 264 (2008) 147–162). (Frank Whitney, Institute of Ocean Sciences)	We have included the Westbrook reference and mentioned this aspect in 6.1.1. but it would not form an element of our discussion of impacts as it relates to WGI, ch 6 and the polar chapter 28.
884	46519	6	84	45	0	0	global ocean ecosystem (Neville Smith, Bureau of Meteorology)	This and our own wording is not very appropriate as with respect to impact there is no global ocean or global ocean ecosystem.
885	40440	6	84	45	85	15	This section needs to be fleshed out more thoughtfully. There are major uncertainties (e.g. interactions between humans and natural systems in a changing climate) that aren't even touched on but should be. (Laura Petes, National Oceanic and Atmospheric Administration)	agreed and amended
886	46772	6	84	47	84	50	If this is indeed the case, which I think it is, then there is a need for changing this state of affairs.Long-term observation of the type that are needed cannot be implemented via national programs alone. So a recommendation will be to recognize that there is still a strong coordinating role for international (both inter- and non-governmental) organizations. (Venugopalan Ittekkot, University of Bremen (retired))	This has been included although we can only state the issue here and cannot be policy prescriptive.
887	46892	6	85	10	85	15	It would be useful to have an outline of a unifying approach so that a recommendation can be taken forward proactively. (Genevra Harker, HarmonicQuay Ltd)	This has been included when phrasing the key uncertainties. We can only state the issue here and cannot be policy prescriptive.
888	46774	6	85	18	88	2	FAQ: I will add another question to the list. Is there sufficient qualified human capacity and infrastructure in countries around the world to study ocean response to climate change? The Chapter mentions on page 85 lines 12-15, "the necessity of long term studies in various climatic zones and biomes" to better understand the inssue of ocean response to climate change. (Venugopalan Ittekkot, University of Bremen (retired))	This point is well taken and has been added to the Key Uncertainties.
889	47159	6	85	18	88	2	Who is the target of the FAQs? There are many technical terms used throughout yet no citations. it seems to assume a reader who doesn't want to consult the literature yet can handle highly technical jargon? I'm not sure who that exactly would be. (Sarah Cooley , Woods Hole Oeanographic Institution)	This point is well taken. We have reduced jargon to make the text more palatable to the general reader.
890	43044	6	85	25	85	27	FAQ 16.1 Some of this answer (charismatic species, drugs, tourism) is not addressing the question of what is fundamental to the planet. (Cliff Law, NIWA)	We need not only address the fundamental issues but also the impact on the human uses of the ocean.
891	40441	6	85	41	85	42	Confusing. Takes 10 million years after what? (Laura Petes, National Oceanic and Atmospheric Administration)	10 million years after the extinction event. This detail has been lost from the revised text.
892	47311	6	85	44	0	0	I think FAQ 6.3 contains too much biological detail, and first needs to explain some basic things about the chemistry, i.e., when CO2 is introduced, [CO3--] goes down. This isn't intuitively obvious to most people, even those with scientific training. (James Christian, Government of Canada)	Agreed but might create overlap with WGI FAQ. We now refer to the ross-chapter box on ocean acidification.
893	40442	6	85	45	86	13	If this is supposed to be for a lay audience, it needs some translation. There's a lot of jargon, and some of these details aren't necessary for addressing the question. (Laura Petes, National Oceanic and Atmospheric Administration)	This point is well taken. We have reduced jargon to make the text more palatable to the general reader. We now refer to the ross-chapter box on ocean acidification.
894	40443	6	86	17	86	32	It would be nice if this were focused also on changes such as shifts in species ranges, which are occurring more rapidly in the oceans than on land), economic implications (as marine-based commerce and tourism is huge), etc. (Laura Petes, National Oceanic and Atmospheric Administration)	We have reduced the number of FAQs in the revision but have an emphasis on range shifts in one of the remaining FAQs,
895	43045	6	86	29	86	29	"breathe water" ? (Cliff Law, NIWA)	We now talk about animals living and breathing in water (for example, fishes, squid, mussels) versus those which also live in water but take in air at the ocean surface for breathing.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
896	40444	6	86	48	0	0	What is the "cul-de-sac" analogy??? (Laura Petes, National Oceanic and Atmospheric Administration)	This detail has been lost from the revised text.
897	47160	6	86	48	86	48	"The cul-de-sac analogy": an example of the fairly jargon-heavy FAQ answer without providing a road sign in the literature to learn more. (Sarah Cooley , Woods Hole Oeanographic Institution)	This detail has been lost from the revised text.
898	48274	6	87	0	0	0	Table 5.2: Top 10 nations with highest proportion of populations include India and China. However no further analysis of institutional structure has been provided in Table 5.4 (Malini Nair, Indian Institute of Science)	Comment not intended for Chapter 6 (Chapter 5!)
899	47312	6	87	11	0	0	I think FAQ 6.6 confuses projections with the present climate. It says that "the manifestation of climate-induced alterations in marine ecosystems goes far beyond the range of natural variability". It is projected to do so in the future, but it hasn't yet. And the question specifically refers to "the changes we see nowadays". It also says that the "current rate of environmental change is unprecedented compared to climate changes in the past". Not necessarily. It will be soon, but not yet. (James Christian, Government of Canada)	This detail has been lost from the revised text.
900	52581	6	87	13	0	0	(should read) ...in marine communities .... (STEPHEN HAWKINS, UNIVERSITY OF SOUTHAMPTON)	agreed and amended
901	40445	6	87	13	87	23	Line 20 mentions adaptation; the problem is that changes are often too rapid for adaptation to occur; this point needs to be made here. Also, rather than a simple "No" answer to this question - can describe how the scientific community is working to understand these interactions. For example, many experiments are underway to test the magnitude, impacts, and interactions of climatic and non-climatic stressors. (Laura Petes, National Oceanic and Atmospheric Administration)	We have emphasized in the FAQ that changes may be too rapid for adaptation to occur.
902	35989	6	87	37	0	0	Is it not appropriate to mention aquaculture as a means of increasing fish production? Ocean farming will likely expand greatly in the future. One concept, for example, is to construct huge (several hectare) pens in warm oceans and feed them with nutrients pumped from depth. I have no doubt that ocean management will be forced to deal with the conflicts of historical marine uses as well as expanding aquaculture and resource extraction (methane, metals etc) (Frank Whitney, Institute of Ocean Sciences)	agreed but this FAQ has been lost from the chapter.
903	37238	6	87	41	0	0	“Since many of the fisheries stocks are fully to over-exploited, a decline in primary productivity is expected to further limit global fisheries production. According to most of the projected scenarios etc.” I don’t follow the logic in this statement. I would suggestr “From a global perspective, the potential for fisheries’ production is ultimately linked to primary (i.e. phytoplankton) productivity, so that a decrease in the latter will lead to a decrease in the former. Regionally, however, according to most of the projected scenarios etc” (Erica Head, Fisheries and Oceans Canada)	agreed but this FAQ has been lost from the chapter.
904	47161	6	96	39	96	40	Update: Cooley, S.R. How humans could “feel” changing biogeochemistry. (2012) Current Opinion in Environmental Sustainability. 4(3):258-263. (Sarah Cooley , Woods Hole Oeanographic Institution)	reference has been updated
905	47162	6	96	45	96	46	Update: Cooley, S.R., Lucey, N., Kite-Powell, H., and Doney, S.C. (2012) Nutrition and income from mollusks today imply vulnerability to ocean acidification tomorrow. Fish and Fisheries. 13:182-215. DOI: 10.1111/j.1467-2979.2011.00424.x. (Sarah Cooley , Woods Hole Oeanographic Institution)	reference has been updated
906	35455	6	155	9	155	9	To include the reference: Vinagre, C., F. Duarte Santos, H. Cabral, and M.J. Costa, 2011: Impact of climate warming upon the fish assemblages of the Portuguese coast under different scenarios. Regional Environmental Change, 11, 779-789. (M. Dolores Garza-Gil, University of Vigo)	Our text is more focused on generic processes and less on regional scenarios which is a focus of Chapter 30.
907	35952	6	156	0	0	0	Table 6-2 confuses me. How can primary productivity be high in low latitude gyres when nutrient supply is low? Emerson and Stump Deep-Sea Research I 57(2010)1255–1265 recently assessed subtropical and subarctic net community production as equal in the N Pacific, even though their subarctic site was within the less productive eastern gyre (nutrient drawdown being two times greater in the western subarctic and Bering, Whitney 2011). Behrenfeld et al (2006) provide a map of ocean productivity which seems to me a better summary of regions of high and low PP. An important facet to PP is the ability of an ecosystem to export carbon to higher trophic levels, something done more effectively in highly productive coastal waters (Ware and Thomson, 2005; Iverson, 1990. Limnol. Oceanogr. 35(7), 1593-1604). (Frank Whitney, Institute of Ocean Sciences)	This detail has been corrected to low to medium and it has been added that the issue is debated.
908	40449	6	156	0	0	0	Table 6-1 is not particularly informative or relevant. Recommend deleting. (Laura Petes, National Oceanic and Atmospheric Administration)	This table may help to categorize sensitivity. we emphasize that in the legend and leave it in.
909	47313	6	156	0	0	0	Table 6-1: columns 2 and 3 are identical across all 3 rows. Is row 3 really necessary? What sort of organisms use radioactive decay as an energy source? (James Christian, Government of Canada)	The use of radioactivity has been hypothesized by Hutchinson and others but not yet shown in nature. It remains a possible mode of energy capture. We have deleted this entry.
910	47314	6	156	0	0	0	Table 6.2: Not sure what is meant by "Strong stratification following vertical transport". Equatorial upwelling is characterized by both continuous vertical transport and permanent density stratification. What is the difference between "mixing" and "eddy diffusion"? Silicate and iron are also supplied by most these same processes and in some of these regions are important limiting nutrients. (James Christian, Government of Canada)	Thank you very much for this comment. However, we cannot go into detail here, as this table provides a rather general overview.
911	40450	6	157	0	0	0	Is Table 6-3 an original analysis, or is it drawn from another study? Kroeker et al. (2010) conducted a meta-analysis of ocean acidification impacts; that could be leveraged here. (Laura Petes, National Oceanic and Atmospheric Administration)	The table is an original compilation of several sources, references are given
912	43059	6	157	0	0	0	Table 6-3: It is interesting that mobile fish come out as more vulnerable than benthic habitats. Is this actually right? (Beth Fulton, CSIRO Marine and Atmospheric Research)	Classifying fishes as "vulnerable" builds on a set of behavioral studies on coral reefs fishes and their resulting exposure to predators. The long-term persistance of these phenomena remains unexplored and thus confidence is low.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
913	39149	6	157	0	157	0	Table 6.3 This table is hard to read because taxa of marine species are not listed in order of increasing (or decreasing) vulnerablity. Nor is it clear at what level of acidity different species will die or be severely adversely affected, and when that acidity level will be reached under the different CO2 emission scenarios developed by the IPCC. Readers will not be able to relate to the data if there are no clear indications of what exactly the consequences of continuing emissions will be for marine life and when these will occurr. If you cannot answer these questions now, say so. But surely, there must be some progress toward quantifying the correlation between ocean acidity and global warming?? (Thomas Reuter, University of Melbourne)	We have now reordered the list according to phylogenetic criteria. This seems a more systematic approach than ordering according to vulnerability. For differentiation between species in the same phylum, the reder is referred to Figure 6-9. To improve understandibility we now give an example in the table caption on how this table is to read.
914	40451	6	158	0	0	0	This table focuses solely on scientific methodology. Could it be made more integrative? If not, recommend deleting. (Laura Petes, National Oceanic and Atmospheric Administration)	This table mentions the diversity of processes contributing to the biological pump. It is meant to complement the respective figure (now Figure 6-6). So it should be viewed together with the figure which it will in the final chapter version.
915	47315	6	158	0	0	0	Table 6.4: I find this table in general rather vague. The effect of ocean acidification on CaCO3 ballasting is discussed by Barker et al 2003 Phil Trans Roy Soc London 361A: 1977-1998. (James Christian, Government of Canada)	This table mentions the diversity of processes contributing to the biological pump. It is meant to complement the respective figure (now Figure 6-6). So it should be viewed together with the figure which it will in the final chapter version.
916	50386	6	158	0	0	0	Table 6-4. It would be helpful to further clarify what is meant in the 2nd to last sentence of the table caption--in what way does this table illustrate the relationship between the knowledge platform and high agreement/robust evidence for the described ramifications? (Katharine Mach, IPCC WGII TSU)	The table legend has been rephrased to make clearer that the complexity of the required knowledge limits any clear conclusions about climate induced effects on the biological pump.
917	47316	6	159	0	0	0	Table 6-5: I would leave out discussion of "human factors" like cost and feasibility. (James Christian, Government of Canada)	The discussion of "human factors" like cost and feasibility has been removed.
918	50387	6	159	0	0	0	Table 6-5. The author team might consider presenting calibrated uncertainty language to reflect its assessed degree of certainty in the outcomes characterized in the 3rd column of the table. (Katharine Mach, IPCC WGII TSU)	Confidence statements have been added.
919	46417	6	159	0	159	0	This table is not very comprehensive. See the CBD report referred to above for a more comprehensive listing. (Chris Vivian, IMAREST)	The table has been updated and complemented with respect to impacts on ocean systems. Other geoengineering approaches are not part of this chapter.
920	46418	6	159	0	159	0	This needs updating with some recent publications including: Smetacek, V. et al. (2012) Deep carbon export from a Southern Ocean iron-fertilized diatom bloom. Nature 487, 313-319. Convention on Biological Diversity (2009) Scientific synthesis of the impacts of ocean fertilization on marine biodiversity. CBD Technical Series No. 45, 53 pp. Wallace, D.W.R., et al. (2010) Ocean fertilization: A scientific summary for policymakers.. IOC/UNESCO, Paris (IOC/BRO/2010/2). (Chris Vivian, IMAREST)	agreed and updated
921	47317	6	160	0	0	0	Figure 6-1 caption: No productivity data are shown. Values in excess of 10 mg do not occur only in EBC regions. I would change "physics and chemistry" to "physical ocean processes". (James Christian, Government of Canada)	The system is driven by both the chemical and physical processes, especially in light of ocean acidification or nutrient availability. Although the subsectioning is mainly shaped by physical processes, these secondary chemical features then also play a role to set biome properties.
922	53911	6	160	0	0	0	Figure 6-1 : As Ch 30 has a very similar figure, consider 1) a way to combine the two figures together And/OR 2) highlight and why and HOW your chapter divides the ocean differently from Ch 30. (Yuka Estrada, IPCC WGII TSU)	Our divisions are based on published literature, chapter 30 has decided to go for larger sections, they have sort of re-defined their own. The question now is how to deal with this as a fundamentally different approach has been taken.
923	47318	6	161	0	0	0	Figure 6-2: I don't entirely understand the histograms. If these are fractions of the historical range why doesn't the scale go from 0-1? The description is ambiguous as to whether this is a fraction or a temperature range, and if it is the latter exactly what it means. (James Christian, Government of Canada)	The figure has been improved and the caption has been rephrased for ease of understanding.
924	53912	6	161	0	162	0	Figure 6-2: A few minor graphical tips for better presentation. Organize all components systematically by placing a panel title at the boom of each panel, and resizing the height of individual maps and corresponding chart to be equal. Move time-interval headings to the left of the map series on the left, and reduce the space between maps series and chart series in the middle. I would also insert a white space between maps of different intervals to let thereaders know that the data presented here are discrete and not continuous, and make sure to align a map and associated frequency chart at the bottom. (Yuka Estrada, IPCC WGII TSU)	The figure has been improved and the caption has been rephrased for ease of understanding.
925	40452	6	163	0	0	0	Figure 6-3 is too complicated as currently presented. The corals are not easy to see (are they supposed to be on the left panel? Not clear from the figure legend.). Also, the panels on the right do not depict directly comparable information to the panels on the left (b/c the timescales are different, these data are showing multiple scenarios, etc.) so would be better presented as a separate figure. (Laura Petes, National Oceanic and Atmospheric Administration)	Figure 6-3 has been dropped from the SOD as it repeats information presented in WGI.
926	47319	6	163	0	0	0	Figure 6-3: This figure really needs work. The lines on the maps are not explained and the black/grey dots referred to in the caption are not visible. The bottom 2 panels at right are global means? At what depth? probably not at the 2C and 25C isotherms. "RCP2.6" has apparently been rounded off to "RCP3". If the maps are model output what does "areas with no data" mean? (James Christian, Government of Canada)	Figure 6-3 has been dropped from the SOD as it repeats information presented in WGI.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
927	53913	6	163	0	0	0	Figure 6-3: It could be more effective if the left side and right side of the figure were divided into separate figures. I was not sure of the benefit of keeping them as a single figure. But if there is a compelling reason, it should be explained more explicitly in the caption. Also, for the maps, the legends have to be labeled clearly and grey dots still need to be more visible. (Yuka Estrada, IPCC WGII TSU)	Figure 6-3 has been dropped from the SOD as it repeats information presented in WGI.
928	36883	6	163	1	164	1	Fig. 6-3: indicate units for saturation and CO2 concentration in the graph and/or in the legend (Antonio Bode, Instituto Espanol de Oceanografia)	Figure 6-3 has been dropped from the SOD as it repeats information presented in WGI.
929	50388	6	164	0	0	0	Figure 6-3. As a minor point, it would be clearest to label explicitly the color scale bar in the figure. (Katharine Mach, IPCC WGII TSU)	Figure 6-3 has been dropped from the SOD as it repeats information presented in WGI.
930	50389	6	165	0	0	0	Figure 6-4A. It would be helpful to clarify the Y axis of the bottom left plot. Does the axis as labeled run from 1000-2000? (Katharine Mach, IPCC WGII TSU)	This figure has been revised for accessibility.
931	53914	6	165	0	0	0	Figure 6-4: Although this figure has a lot of informative data, I found it very cumbersome to read. For instance, having the y-axis placed at various levels makes it harder for readers to find the appropriate scale and title for a given data. Improving presentations (i.e., clean up and clarify the y-axis labels, use of legend etc.) would benefit the reader to understand the main points of the figure easily. (Yuka Estrada, IPCC WGII TSU)	This figure has been revised for accessibility.
932	40453	6	165	0	167	0	Figure 6-4 (both panels) would be much more informative if they were directly comparing information (ideally, even using the same scales on the y-axes) across the two sub-panels shouwn within each panel. For example, "last glacial maximum" and "industrialisation" top panels on Fig. 6-4B would both show the percentage of warm water foraminifers, etc. (Laura Petes, National Oceanic and Atmospheric Administration)	This figure has been revised for accessibility.
933	36884	6	165	1	166	1	Fig. 6-4: check for readability of labels in the final version (Antonio Bode, Instituto Espanol de Oceanografia)	This figure has been revised for accessibility.
934	40454	6	168	0	0	0	Figure 6-8 is really useful. There are a few ways it could be improved. For example, "climate" operates over weekly, monthly, annual, and decadal scales as well (not just centennial) - there should be a way to depict that here. MLD should be spelled out. Are "Langmuir cells" described elsewhere in the text so the reader is familiar with them? (Laura Petes, National Oceanic and Atmospheric Administration)	The comment refers to Figure 6-5. This figure has been revised for accessibility. We have considered that "climate" operates over weekly, monthly, annual, and decadal scales as well (not just centennial). Abbreviations like MLD have been spelled out. "Langmuir cells" are defined in the figure caption. Short term changes in climate is really 'weather'.
935	40455	6	169	0	0	0	Figure 6-6 is really confusing, particularly the contents of the green box, which includes way too much information that presents too many different concepts. Could this be simplified? Why is "food chain" simply a connected sub-box, and how does it connect back to other processes? The "global warming" box should say something broader like "climate change" - is it supposed to lead directly to each of the boxes below (e.g. hypoxia)? If not, how are they connected? (Laura Petes, National Oceanic and Atmospheric Administration)	Figure 6-6 (Mandala) has been dropped from the SOD and replaced by former Figure 6-15.
936	53915	6	169	0	0	0	Figure 6-6: The use of color is not quite clear in this diagram. For instance, the top blue line indicating “ocean” looks like the same shade of blue used in illustrating the possible feedback mechanisms. Double outlines of dark and light green are very hard to see. Are the arrows coming out of blue boxes part of the indirect climate factors illustrated in black? Some re-organizing and reconstruction could improve the presentation of this figure. For instance, a different shape could be used for different components (e.g, square for organisms, circle for environmental factors, etc). It is also not clear what “highs” and “lows” outside of the green box in the middle are indicating. (Yuka Estrada, IPCC WGII TSU)	Figure 6-6 (Mandala) has been dropped from the SOD and replaced by former Figure 6-15.
937	36885	6	169	1	169	1	Fig. 6-6: check for readability of labels in the final version (Antonio Bode, Instituto Espanol de Oceanografia)	Figure 6-6 (Mandala) has been dropped from the SOD and replaced by former Figure 6-15.
938	53916	6	170	0	0	0	Figure 6-7: It would be helpful to have further clarification of some components in each panel such as legend and axis-titles. For instance, what are the meanings of different colors used in Panel A? What are the arrows representing? How is the aerobic thermal window changing from left to right in panel B? What exactly is the x-axis of Panel C indicating and how its it changing from left to right? How is the climate warming represented in Panel D? (Yuka Estrada, IPCC WGII TSU)	This figure is a schematic, so one should not expect rigorous quantitative labels on the axes etc. The relevant information has been added to the caption.
939	46775	6	170	0	171	0	If , as mentioned on Page 29, lines 20-22, OCLTT is a concept that is applicable "to integrate findings across levels of biological organization….", then perhaps the concept can be explained in a BOX, with the figure? (Venugopalan Ittekkot, University of Bremen (retired))	The figure is Figure 6-7. The explnations have been improved in the leged. Due to severe space restrictions, we can unfortunately not add more text.
940	36886	6	170	1	170	1	Fig. 6-7: check for readability of labels in the final version (Antonio Bode, Instituto Espanol de Oceanografia)	We will make sure, together with the experts of TSU that labels in the final version will be readable.
941	53917	6	172	0	0	0	Figure 6-8: A neat idea to organize the information but again it would be helpful to improve the presentation. It seems to be confusing to have a little graph inserted in the oxygen diagram the way it is since on the y-axis of the graph, relative species richness is not expressed in the oxygen diagram. Also, it would be helpful to have a clarification of the thermal window of the domain diagram. Does the wider shade of Archea represent its wider tolerance range for temperature compared to Bacteria but not for the oxygen level? It may be useful to include the information on the lower temperature limit for growth (page 37 lines 25-28). (Yuka Estrada, IPCC WGII TSU)	Thank you for these suggestions, they make sense. We have considered these suggestions in the SOD version of this figure and improved the explanation.

#	#	Ch	From Page	From Line	To Page	To Line	Comment	Response
942	53918	6	174	0	0	0	Figure 6-9: A very informative figure. But, (A) it was not quite clear what the – and + sings indicate for the Calfcitaion site/rate; (B) the y-axis title does not make sense. Also, it was not clear what exactly the numbers on the top of the columns show from the caption. Is the total number of species studied for a given group (i.e., Corals) represented as the number above the Control Column (i.e., 22 for Coral)? Can the numbers be expressed as n= OO. Also, the audience may be more familiar to see * for denotation of significance level of p<0.05. (Yuka Estrada, IPCC WGII TSU)	Thank you for these suggestions. We have considered them in the SOD version of this figure. We have changed the y-axis title and now explain the numbers above the columns in more detail.
943	47320	6	176	0	0	0	Figure 6-10: Chlorophyll anomalies are referred to in the caption but no chlorophyll data are shown. "interpolating, smoothing, and differencing" needs to be better explained. 1991-94 El Nino peaked in 1991-92 not 1992–1993. (James Christian, Government of Canada)	We have clarified these issues and revised the legend accordingly focusing on the key issues.
944	53919	6	176	0	0	0	Figure 6-10: It would be helpful to restate "…all the sites except Cariaco seem to show positive (pink) PP anomalies after 2000" as it gives an impression that only positive PP are illustrated after 2000. Also, the caption should note that the y-axis scale is different in each panel. Or preferably, use the same scale for all panels to make direct comparisons. (Yuka Estrada, IPCC WGII TSU)	We have clarified these issues and revised accordingly.
945	47321	6	177	0	0	0	Figure 6-11: Exactly what is shown in panel B needs to be better explained. How can there be annual values of year-to-year variability? Is it for a running window around the year shown? How broad is the window? In panels C+D the land mask could be expanded to cover the major land areas (like the northern half of Britain). (James Christian, Government of Canada)	The local variance was calculated directly on the ecosystem state to examine the local variance of the ecosystem state, using a technique that is derived from the method of point cumulative semi-variogram (PCSV; (Sen Z (1989) Cumulative semi-variogram models of regionalized variables. Mathematical Geology 21:891-903). Therefore, there is no need for a time window contrary to other statistical techniques. All time windows are considered (multiscale local variance). The mathematics of the statistical analysis is fully described in Beaugrand et al. (2008). This point was clarified in the figure legend. The position of landmask has been amended.
946	50390	6	178	0	0	0	Figure 6-11. Do all data presented in this figure pertain to the North Sea? Assuming this is the case, I would suggest clarifying the geographical scope of information presented in each part of the figure (A-F). (Katharine Mach, IPCC WGII TSU)	No this is not exactly the case that is why we prefer to keep the figure legend as it is
947	40456	6	180	0	0	0	Figure 6-13 is confusing. What are the two large arrouws for benthos and small fishes supposed to depict? Why the sub-set of images showing "bethos, small fishes, large fishes" below the trophic web? (Laura Petes, National Oceanic and Atmospheric Administration)	We have clarified these issues and revised accordingly.
948	43060	6	180	0	0	0	Figure 6-13: In the bottom panel it maybe worth truncating the body size length of some of thehorizontal bars per TL to get across the shifting size distributions. Would be good to also incorporate expected marine mammal and benthic shifts too (so its all in one place rather than disjointed through the document) (Beth Fulton, CSIRO Marine and Atmospheric Research)	We have clarified these issues and revised accordingly.
949	53920	6	180	0	0	0	Figure 6-13: Panel labels are missing. This is another complicated figure that could benefit from further clarification. For instance, it is not clear what the big white arrows above Benthos and Small fishes are indicating. There may be a little too much detail presented here for readers to determine the key concept. (Yuka Estrada, IPCC WGII TSU)	We have clarified these issues and revised accordingly.
950	40457	6	182	0	0	0	Figure 6-14 isn't particularly relevant. "Biome" could be deleted, as individual, population, and ecosystem are sufficient for capturing the diversity of scales. (Laura Petes, National Oceanic and Atmospheric Administration)	We have converted the figure into a table
951	50391	6	182	0	0	0	Figure 6-14. Although the figure caption implies that the circles containing numbers should have different sizes, they all seem to be the same size to me. (Perhaps this is a detail not yet incorporated in the figure.) (Katharine Mach, IPCC WGII TSU)	We have converted the figure into a table
952	53921	6	182	0	0	0	Figure 6-14: This information may be better represented as a table. (Yuka Estrada, IPCC WGII TSU)	We have converted the figure into a table
953	36887	6	182	1	182	1	Fig. 6-14: check for readability of labels in the final version (Antonio Bode, Instituto Espanol de Oceanografia)	We have converted the figure into a table
954	43061	6	184	0	0	0	Figure 6-16: Colour seems to be missing from the plot? (Beth Fulton, CSIRO Marine and Atmospheric Research)	The original version is coloured. probably due to cover into pdf. This will be checked when the chapter is copy edited.
955	36888	6	184	1	184	1	Fig. 6-16: check for readability of labels in the final version (Antonio Bode, Instituto Espanol de Oceanografia)	We made sure labels are readible.
956	40458	6	186	0	0	0	Typically increases are portrayed with warmer colors (oranges, yellows), whereas decreases are depicted with cooler colors (blues, purples). It would make more intutitive sense to the reader if presented that way instead of vice versa. (Laura Petes, National Oceanic and Atmospheric Administration)	Because a decrease here is inferred to have negative impacts, and a warmer colour is often associated with negative impacts, we decided to use warmer colours for any decrease. This is also consistent with the figure in the original publication.
957	40459	6	188	0	0	0	The concept of Figure 6-18 is very useful. However, it would make more sense if this were separated into 2 panels - one on organisms (e.g. salmon) and one on methods of attribution (e.g. observations in the geological record)?. What's the difference between microbial concepts and microbial effects? (Laura Petes, National Oceanic and Atmospheric Administration)	Thank you. We have separated the figure into two panels - one on specific examples (e.g. salmon) and one on broad categories. The difference between microbial concepts and microbial effects is explained in the text.
958	36889	6	188	1	188	1	Fig. 6-18: check for readability of labels in the final version (Antonio Bode, Instituto Espanol de Oceanografia)	agreed and amended