

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
1	35077	28	0	0	0	0	The chapter was very well written and up to date. There are a few additions that need to be made based on more recently published research. (Kevin Arrigo, Stanford University)	Acknowledged
2	35251	28	0	0	0	0	The Norwegian Polar Institute would like to congratulate the authors of the chapter. For the most part, it is balanced and clear and it covers nearly all relevant topics. From our point of view the cited literature in most sections provides a balanced picture of the challenges and impacts of climate change in the Polar Regions. (Ellen Øseth, Norwegian Polar Institute)	Acknowledged
3	35254	28	0	0	0	0	The relationship between environmental pollution and climate change is not discussed in the chapter. The only place where it is mentioned is in Chapter 28.2.4 Human populations, page 27, line 17-34, and then only regarding human health and well-being. Elevated levels of man-made contaminants have been measured in both Polar Regions due to the cold-condensation effect. The details of how climate changes will affect transport and deposition of contaminants to the Arctic region are unclear. The effects of climate alterations are already being observed in the Arctic with decreases in ice content/thickness, increase in air/water temperatures, and changes in oceanic/atmospheric circulation. Increase in temperature would promote greater volatilization of POPs from water, decreasing contaminant loading. However, increased temperatures will also promote melting of snow and ice, which have been shown to be storage mediums for POPs, increasing contaminant loading from melt water. Greater influence of Atlantic water masses into areas traditionally dominated by Arctic water could cause an influx of contaminants from equatorial regions. However, this deposition mechanism may be counteracted by increased volatilization mentioned previously. Climate change will affect many POP deposition and transport mechanisms to the Arctic, but it is unclear which of these mechanisms will dominate. Previous sinks for contaminants could become important sources in the coming years. Persistent organic pollutants (POPs) accumulate in lipids, and are transferred through predator – prey relationships, leading to elevated contaminant levels progressing up the food web. It is well known that Arctic animals undergo large seasonal variations in e.g. lipid content, metabolism and growth. Additional stress caused directly or indirectly by climate change can contribute to increasing effects of POPs. Suggested literature: Title: Revolatilization of persistent organic pollutants in the Arctic induced by climate change Author(s): Ma Jianmin; Hung Hayley; Tian Chongguo; et al. Source: NATURE CLIMATE CHANGE Volume: 1 Issue: 5 Pages: 255-260 DOI: 10.1038/NCLIMATE1167 Published: AUG 2011 Title: How do persistent organic pollutants be coupled with biogeochemical cycles of carbon and nutrients in terrestrial ecosystems under global climate change? Author(s): Teng Ying; Xu Zhihong; Luo Yongming; et al. Source: JOURNAL OF SOILS AND SEDIMENTS Volume: 12 Issue: 3 Pages: 411-419 DOI: 10.1007/s11368-011-0462-0 Published: MAR 2012 Times Cited: 0 (from Web of Science) Robert J. Letcher, Jan Ove Bustnes, Rune Dietz, Bjørn M. Jenssen, Even H. Jørgensen, Christian Sonne, Jonathan Verreault, Mathilakath M. Vijayan, Geir W. Gabrielsen, 2010. Exposure and effects assessment of persistent organohalogen contaminants in arctic wildlife and fish. Science of the Total Environment 408 (2010) 2995–3043 JAN O. BUSTNES, GEIR W. GABRIELSEN & JONATHAN VERREAULT. 2010. Climate Variability and Temporal Trends of Persistent Organic Pollutants in the Arctic: A Study of Glaucous Gulls. Environmental Science and Technology 44: 3155-3161 (Ellen Øseth, Norwegian Polar Institute)	Section on Arctic pollution has been added.
4	35409	28	0	0	0	0	I have some concerns about the lack of Antarctic experts in the CLA/LA group. This has been partially reduced by the inclusion of several Antarctic experts as CA, but the preponderance of UK participants in this group, will probably raise some hackles, and does not make best use of a large multinational Antarctic science community. (David Vaughan, British Antarctic Survey)	The chapter team now includes an LA with Antarctic expertise
5	35415	28	0	0	0	0	Figure 28-5 I think that the caption, when written, really (David Vaughan, British Antarctic Survey)	Comment not understood.
6	36616	28	0	0	0	0	The sections of this chapter provide details on a wide variety of eco-system processes but no real attempt is made to produce a synthesis. Because each process is treated individually and components are not combined through models, one is left with an unsatisfied feeling of gaining key knowledge. What we need to know are : what are the advances in understanding of the impacts and what are the key unknowns? Each section should have a synthesis section at the end. For example, what are the likely changes in landed catch? What is the likely land-use change? What is the increased risk of wild fires? Many sections are far too lengthy, discussing at length the breath of issues, but not the key components (that require additional observations/modelling)? There is almost no cross referencing to WG1 and climate model projections. Finally there is often the phrase 'high/medium/low confidence that ...' without indication on how (quantitatively) that level of confidence is derived. (Jeff Ridley, UK Met Office)	Acknowledged. All IPCC chapters have to use the standardized plainy aproved templates, which implies that the structure is set, and it is not possible to have summary and key messages in the end of every section. Paul will add some text on synthesis of the ecosystem's sections. There will also be an attempt to synthesize findings in the figures. Attribution and Detection tables for marine and terrestrial ecosystems were developed
7	36658	28	0	0	0	0	In the review of the ZOD, several comments were made regarding organization and regarding the exclusion of several relevant recent publications (citations for recent publications were provided). However, it appears that many of these suggestions/comments have not been incorporated into the FOD. This is unfortunate as inclusion of these suggestions would have greatly improved the chapter. A number of comments provided for the review of the FOD are therefore similar to those provided during the ZOD review. (Sharon Smith, Geological Survey of Canada)	New citations have been included for the SOD text.

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8	36659	28	0	0	0	0	The focus of WG2 should be on impacts and adaptation. However the chapter does a poor job on addressing these themes with respect to impacts on the terrestrial environment, specifically as it concerns infrastructure and related adaptation issues. Several suggestions/comments were made in ZOD review specifically regarding issues related to permafrost and efforts in Canada (including specific reports) associated with incorporation of climate change into infrastructure design and guidance documents to facilitate adaptation. These have not been included in the FOD and should be if this report is to reflect recent advances concerning these issues (some of these efforts relevant to Canadian polar region have even been briefly mentioned in ch 26 -North America). Please note that it is not normal for these documents to be in what the authors might consider peer reviewed literature (journal papers) but rather in various government or other agency reports (which are still extensively reviewed). Detailed comments regarding these issues are provided again in specific comments below. The lack of an author with strong background in permafrost and engineering may be the reason these issues are not adequately covered. (Sharon Smith, Geological Survey of Canada)	We acknowledge the comment. Impacts of thawing permafrost on infrastructure and the adaptation options have been discussed in detail in the recent SWIPA report. One of the chapter CLAs, Oleg Anisimov, was part of the SWIPA writing team, in particular he participated in writing the SWIPA section on permafrost and infrastructure together with Arne Instanes, who took a lead in this work. It is beyond the scope of IPCC assessment report to replicate the major findings of SWIPA or any other report although those are acknowledged in the section devoted to the overview of the findings of previous assessment reports. This has been done. To the best of our knowledge there have been no essentially new findings regarding the impacts on the infrastructure and adaptation options since SWIPA. The other consideration that has to be taken into account, is that IPCC reports consider climate impacts at far more general level than requested by the reviewer. It is thus not feasible to get into fine technical details, which readers can find in the more focused thematic reports exemplified by those of AMAP and the Arctic Council. Efforts would be made to reflect your suggestions for additional references.
9	36660	28	0	0	0	0	Although it is a good idea to refer to previous assessment/synthesis reports, major original research articles especially those published in the last couple of years also need to be cited. Note that the Canadian assessment (Furgal and Prowse 2008) and the papers summarizing its results (e.g. Prowse et al. 2009) are based largely on research results published prior to 2007. The SWIPA report is largely based on research results published prior to 2010. These reports therefore do not include a considerable amount of research conducted during the IPY which represents some important advancements that should be included in AR5 (see specific comments below). There was also a real effort during IPY to better characterize current conditions (e.g. for the cryosphere) and how they are changing which is essential information for developing adaptation strategies. There was also an effort to make this data and information available so it could be used by a wide variety of users including communities, practitioners, decision makers etc. (Sharon Smith, Geological Survey of Canada)	See response to comment above. Efforts will be made to incorporate the most recent results from IPY and TICOP publications
10	38282	28	0	0	0	0	Looking at figures and tables made for the different chapters, there are similarities (e.g. magnitude of temperature and rainfall changes, impacts on ecosystems...) between chapters because they have they deliver similar information, but for different regions. (Guillaume Simioni, INRA)	at the later IPCC stage this will be addressed through cross checking chapters for overarching.
11	38283	28	0	0	0	0	Having a similar layouts (i.e. same styles and legends, symbols, columns, colors, ...) across the chapters, would help the comparison between regions. Not sure it is important, especially if the readership is different from one chapter to another. It's just a suggestion. (Guillaume Simioni, INRA)	see above
12	41018	28	0	0	0	0	See comment for Chapter 26 page 2 line 16 below (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	Noted.
13	41981	28	0	0	0	0	Practically nothing was said about carbon-permafrost-climate feedbacks and their potential importance for the global climate (Vladimir Romanovsky, University of Alaska Fairbanks)	This falls into WG-1 domain and there is a consensus between the chapter authors that it should not be adressed here.
14	43647	28	0	0	0	0	The chapter needs to be carefully checked editorially for errors (use of comma and parenthesis, capital letters, italics for species, space btw words etc.) The chapter would be better if there would be more figures to illustrate cases and facts, now there is very little of figs. For example add a map of areas occupied by different indigenous people. The chapter includes much redundancy in various subchapters. Please improve the focus of each section and then cross refer to what has been already said. (Marjut Kaukolehto, University of Helsinki)	Editorial changes will be made at a later stage when the text is finalized.
15	44567	28	0	0	0	0	General comment: We were surprised to find that this entire chapter contains few cross-references to the WGI AR5, with only 3 citations to Chapter 4 concerning observed changes in Sea Ice, Permafrost, and river ice. For example, there is no reference to WGI AR5 concerning projected changes in temperature/precipitation in the polar regions, or related impacts on the cryosphere. Please update relevant statements to ensure consistency and cross-referencing with the WGI AR5 chapters, including the Annex I: Atlas of global and regional climate projections. (Thomas Stocker, IPCC WGI TSU)	More cross-referencing has been included.
16	44667	28	0	0	0	0	General note - the text is not logical - It is dedicated to the differences between Arctic and Antarctic, however in Arctic the reendeers are discussed, in Antarctic section - the Antarctic Treaty (Maria Ananicheva, Institute of Geography)	Noted. We are striving to achieve better balance between the Arctic and Antarctic representation in the chapter.
17	44692	28	0	0	0	0	2008 черная книга, стр. 22). Russian language! (Maria Ananicheva, Institute of Geography)	fixed.

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18	44721	28	0	0	0	0	1) The structure seems should be improved, there are repeats in different sections 2) sometimes logic is missed - different content for Arctic and Antarctic (thou in the same topic) 3) for me, the glaciologist, physical geographer, the content is too focused on species conditions and their ways of development, less on - ecosystems themselves, consequences of climate change for human 4) Too little Russian and non-English speaking countries literature has been used for the text of ZOD 5) That is why there some gaps in the ZOD, however some of them are mentioned as the tasks for next version 6) The role of snow and ice, ice caps, ice sheets and mountain glaciers under climate change is not sufficiently described 7) SWIPA volume should be used for this chapter, when published (Maria Ananicheva, Institute of Geography)	Points noted. More Russian literature has been sought. Need to check that the FOD rather than ZOD is considered. We dismiss the comment.
19	44783	28	0	0	0	0	The "Polar Regions" chapter now utilises a broad definition of the Arctic as the area above the Arctic Circle, referring to Arctic work such as the ACIA and the AHDR. However, while the chapter notes that between 4-9 million people can be seen as living in the Arctic, it to a large extent focuses on the between 400 000-1.3 million indigenous, and from a largely traditional subsistence perspective. The chapter would need to acknowledge that much of the situation that is described as traditional indigenous applies to (and is drawn largely from literature on) only four of the eight states that are part of the Arctic according to the Arctic council (following definitions of the area earlier in the text). The situation in the area with relation to traditional indigenous lifestyles differ markedly between the often emphasised situation in Canada, Alaska, Greenland and Russia and the relatively more modernised and integrated context of northern Norway, Sweden, Finland and Iceland. The AHDR notes briefly as follows: that Sweden together with Norway, Finland and Iceland are relatively densely populated compared with other of the areas in the Arctic (three quarters of the population of the Arctic outside Russia) and have a number of common characteristics including "remarkably advanced" communication and transportation systems, public services and tertiary sectors (AHDR 2004: 76), as well as relatively high economic diversification and a large contribution to the economy. The report also notes that these areas together make up one fifth of the Arctic economy, and that health situations among Saami are largely indistinguishable from health situations of majority populations in these countries. This northern European context also includes relatively integrated indigenous populations whose land use (notably reindeer husbandry) is integrated in a market system (sale of meat, not only subsistence use) drawing upon relatively high technology use (monitoring and migration of reindeer using trailer trucks, gps on reindeer in test cases, and in some cases helicopter surveillance). This IPCC chapter currently, drawing upon mainly North American and Greenlandic literature, overemphasises the differences between indigenous and local people for this area - indigenous have in the Old World context co-existed with what is in this report called organised "settlers" as early as in the 1600s (long before the development of independent states in the North America). The very compressed timeline of settlement in North America, associated with the frontier development there, has resulted in very different situations and problems in these areas (somewhat comparative to Greenland and parts of Russia) than in northern Norway, Sweden, Finland and Iceland. The chapter needs to acknowledge these differences in situation in the tone of the chapter in general (all human and economic parts), for instance by a more balanced focus that does not only target traditional indigenous subsistence; clarify the timeline of settlement and that not only "recent settlers" constitute the non-indigenous population and change this wording (in fact, populations are often mixed, given the long period of co-habitation in areas in northern Europe); and clarify the limited extent of subsistence only occupations for these countries. See for instance Keskitalo, E. C. H. (2004) Negotiating the Arctic. The Construction of an International Region. Routledge, New York and London (for a critique of the traditional indigenous and environmental conception of the Arctic; Keskitalo, E. C. H.; G. Malmberg, K. Westin, U. Wiberg, D. K. Müller, Ö. Pettersson (submitted) "Contrasting Arctic and mainstream Swedish descriptions of northern Sweden: the view from established domestic research" for a description of the differences in description between domestic Swedish research on the north and "Arctic" literature; Keskitalo, E. C. H. and C. Southcott (in prep.) Globalization. Arctic Human Development Report II, for a description of the way in which the Arctic is today relatively globalised and affected by modernising and other trends and that contradict a simplified traditionalised view. (E. Carina H. Keskitalo, Department of Social and Economic Geography)	Reviewer comment will be acted upon by appropriate chapter authors while preparing the new edition of SOD
19.2	44783	28	0	0	0	0		

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20	45180	28	0	0	0	0	The structure of the chapter should be more consistent across the different sections. For example, most of them are based on differentiating Arctic and Antarctic, which is an obvious and good organization given the differences between the two systems. But this structure disappears in 28.2.3 to 28.2.5 (same for 28.3.3. to 28.3.5). I know that there is a big unbalance here of the effects of climate change on terrestrial ecosystem, and human community between the two poles. However, I think it is important to keep differentiating Arctic and Antarctic sections, and in an introductory paragraph, to provide why there are far more studies in the Arctic (it might not be so obvious for the general audience that for example there is no permanent human settlement in Antarctica!). I also found that the section describing observed and projected impact on Antarctic terrestrial environment (28.2.3.8 to 28.2.3.10), focuses more on other drivers, i.e. human impact related to climate change. I think this should be treated as separate sections, both including Arctic and Antarctic. Finally, I was disappointed by the projected impact of climate change section, which I think should deserve more attention. A major gap defined in AR 4 was that “Most AR4 studies of future climate change were based on a small number of studies using SRES scenarios (...). This allowed some limited, but incomplete, characterization of the potential range of futures and their impacts”. It is highlighted as one of the seven key themes addressed in the AR5: “Advances in integrating physical climate science with human and natural systems to assess impacts.” Since AR4, the number of studies directly linking output from climate models using SRES scenarios and ecological models has increased, not enough to give a complete picture but still this effort need to be acknowledged to motivate and provide guidelines to future studies. These studies focused particularly on selected species such as penguins or polar bears. Polar bears were consequently listed on the American Endangered Species Act because they are threatened by climate change (first species to be listed for that reason). In the observed impact section, the description of the impact of climate change on polar bear is very complete and in fact cites studies of future projected impacts. This should be moved to the appropriate section, or at least mentioned in 28.3.2.1. For penguins and other seabirds, it needs also to be incorporated in 28.3.2.2. Finally, the appropriate vocabulary defined for uncertainties in Chap 1 (both on likelihood of the outcome and confidence in the finding) should be used. (Stephanie Jenouvrier, Woods Hole Oceanographic Institution)	A lot of time and efforts have been put into developing the current structure of the chapter. Striving to achieve the balance between the Polar regions while recognising there are differences and issues and available literature for us to access. Re comment about no comment in report that “no permanent human settlements in Antarctica” was addressed by stating that fact in the first sentence of the “Human Populations” (28.2.4)
21	48953	28	0	0	0	0	In the circum polar arctic, different region is affected differently by climate change the last 30 years, and projections for the future reflect large variation between regions. It is important to include this perspective in the chapter. For example eastern Siberia will have little effect of a mean winter temperature increase from – 43 degree C to -35 degree C, while in other region a minor increase of 2 degree C in winter could have strong effects. Likewise, regions not affected by climate change in winter, could have large effects in summer. Forest fires in early summer in eastern Siberia seem to increase and is a problem for the environment and the local societies. The problems of forest fires and climate change is not included in the chapter and should. Setting the frame is important before discussing adaptation. Downscaling of local climate data is one way to address this problems and should be included in the analysis (Benestad et al 2006, Intr J Climatology). Furthermore, there is a lack updated information about regional differences on snow and snow change in particular in the spring. The ongoing changes raise important ethical question about knowledge production, resource extraction and sustainable development in the Arctic. The changes reported in the chapter is alarming, and the author should therefore include a paragraph about ethics of climate change and Arctic societal development. Adaptation to climate change demand training of local Arctic leaders in long term sustainable thinking, based on the best available adaptation knowledge, both scientific and experienced-based traditional and local knowledge. The chapter should include a paragraph on competence building as an adaptation strategy. Data on learning and education related to climate change in the Arctic is required. (Svein Disch Mathiesen , International Centre for Reindeer Husbandry)	Acknowledged, will address these points in SOD with particular attention to forest fires that are currently underrepresented. We have to be not policy prescriptive introducing the issues of ethics into the report, which is focused on the impacts of climate change and adaptation to these impacts. These comments require a number of answers. See responses (attachment #2)
22	48954	28	0	0	0	0	(Mathiesen continued) A more clear discussion about the role of marked economy in Arctic societies should be discussed. Recent literature from Europe on degradation on grazing land for reindeer have to be included: UNEP. 2010. Johnsen K. I., Alfthan B., Hislop L. & Skaalvik J. F. (Eds). 2010. Protecting Arctic Biodiversity. United Nations Environment Programme, GRID-Arendal, www.grida.no Vistnes I. & Nellemann C. 2001. Avoidance of cabins, roads, and power lines by reindeer during calving. Journal of Wildlife Management 65, 915-925. Vistnes I. & Nellemann C. 2009. Impacts of human activity on reindeer and caribou: The matter of spatial and temporal scales. Polar Biology 31, 399-407. Vistnes et al 2009. Reindeer Husbandry and Barents 2030 Impacts of future petroleum development on reindeer husbandry in the Barents region. www.reindeerportal.org Nellemann C. & Thomsen, M. G. 1994: Terrain ruggedness and caribou forage availability during snowmelt on the Arctic Coastal Plain, Alaska. Arctic 47, 361-367. Nellemann C. & Fry G. 1995. Quantitative analysis of terrain ruggedness in reindeer winter grounds. Arctic 48, 172-176. Nellemann C. & Cameron R. D.1996. Effects of petroleum development on terrain preferences of calving caribou. Arctic 49, 23-28. Nellemann C. & Cameron R. D.1998. Cumulative impacts of an evolving oilfield complex on the distribution of calving caribou. Canadian Journal of Zoology 76, 425–1430. Further more a more clear description of multilevel governance and adaptations is needed. (Svein Disch Mathiesen , International Centre for Reindeer Husbandry)	Several of the references suggested by this reviewer are outdated for the IPCC report. The report includes significant coverage of both the formal and informal economy, including reindeer herding. We acknowledge the comment and will work on it further in SOD

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23	49214	28	0	0	0	0	This chapter suffer in our opinion of a lot of repetition, e.g. in the discussion of reindeer and introduction of non-local species. The chapter would benefit from a more compact and better structure. Since after all there are not that many commonalities between the Arctic and the Antarctic polar regions, it might be an idea to divide the chapter in two; Arctic and Antarctic, and have one section that points out the similarities. Please go through the chapter again with a critical eye for repetitive and or redundant material. (Oyvind Christophersen, Climate and Pollution Agency)	Efforts are made to improve the structure taking into account a large range of views expressed by different reviewers. Dividing the chapter into the two separate chapters is an interesting idea to discuss while planning the next assessment report.
24	51743	28	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 solid 1st-order draft. In an effort to inform further chapter development, I provide some general and specific comments below. (Katharine Mach, IPCC WGII TSU)	Acknowledged
25	51744	28	0	0	0	0	2) Highlighting key findings -- In developing the 2nd-order draft, the chapter team should aim to present key findings throughout the sections of the chapter, using calibrated uncertainty language to characterize its degree of certainty in these conclusions. In this way, a reader of the chapter will be able to understand fully how the literature reviews and syntheses in the chapter sections--the traceable accounts--support the conclusions of the chapter, especially those presented in the executive summary. (Katharine Mach, IPCC WGII TSU)	Acknowledged
26	51745	28	0	0	0	0	3) Usage conventions for calibrated uncertainty language -- Where used, calibrated uncertainty language, including summary terms for evidence in agreement, levels of confidence, and likelihood terms, should be italicized. In addition to incorporating these terms directly into sentences, the author team may find it effective to present them parenthetically at the end of sentences or clauses. In using likelihood terms, the author team should ensure that there is a probabilistic basis for their assignment, in this way consistent with the uncertainties guidance for authors. Casual usage of the reserved uncertainty terms should be avoided, as has been flagged in some specific comments throughout the chapter. (Katharine Mach, IPCC WGII TSU)	Acknowledged. Calibrated uncertainty language was used in this document. While projection models exist, we elected to use confidence language. We also developed detection attribution tables.
27	51746	28	0	0	0	0	4) Specificity of described observations and projections -- The author team is encouraged to continue presenting observed and projected impacts and trends with specificity and conciseness. In this vein, the author team should continue the following practices: indicating relevant time periods, geographic areas, etc. for observations; indicating the relevant time frames, scenarios for climate change or socio-economic development, geographic regions, or other assumptions for projections; and characterizing key driving factors where ranges of outcomes are presented. (Katharine Mach, IPCC WGII TSU)	Acknowledged. Scenarios however not available (econ).
28	51747	28	0	0	0	0	5) Conditional constructions -- The author team may wish to consider further use of conditional constructions that explicitly separate a given physical change from its corresponding conditional impact. The chapter team is encouraged to continue using such constructions, also separately characterizing the degree of certainty for the physical change and conditional impact where appropriate. (Katharine Mach, IPCC WGII TSU)	Acknowledged
29	51748	28	0	0	0	0	6) Plenary Approved Outline -- The author team should ensure that all topics are addressed as can be supported by the literature. (Katharine Mach, IPCC WGII TSU)	Acknowledged
30	51749	28	0	0	0	0	7) Reduction of chapter length -- Wherever possible, the chapter team should aim to shorten and tighten chapter sections upon revision. In particular, background material not directly relevant to climate change impacts, adaptation, and vulnerability should be reduced. The filter throughout should be for development of policy-relevant assessment. Many sections would be strengthened by being reduced by 30% or more. A substantial check should be performed for analogous subsections of 28.2 and 28.3. The author team should ensure that material in 28.2 focuses on observations, while material in 28.3 focuses on projections, with overlapped reduced accordingly. Additionally, appropriate consistency of assessment should be insured across analogous subsections. (Katharine Mach, IPCC WGII TSU)	Acknowledged
31	51750	28	0	0	0	0	8) 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 chapters 5, 6, 30, etc. to ensure harmonized assessment, with logical handoffs between sectoral and regional treatment, with consistency in findings presented, and with overlap reduced wherever possible. (Katharine Mach, IPCC WGII TSU)	Acknowledged
32	51751	28	0	0	0	0	9) 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)	Acknowledged
33	52649	28	0	0	0	0	Generally rather good level of biological information, however e.g. information/discussion on invasive/alien species in the Arctic could be expanded/included (Else Marie Løbersli, Norwegian directorate for nature management)	Acknowledged
34	52650	28	0	0	0	0	The structure of the chapter could be improved for example for finding particular climatic change drivers and their biological consequences (Else Marie Løbersli, Norwegian directorate for nature management)	We make such linkages as appropriate and available.
35	52743	28	0	0	0	0	(NOTE) Please see Review Comments to Chapter 28, "Polar Regions," First Order Draft of the IPCC-5, WGII by Igor Krupnik, Smithsonian Institution, Washington, D.C. Dr. Krupnik wrote his review in essay form, and has 5 pages that are difficult to put into specific comments, but contains information that the authors will find valuable. (Igor Krupnik, Smithsonian Institution, National Museum of Natural History)	Acknowledged

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36	54556	28	0	0	0	0	GENERAL COMMENTS: I would like to thank the authors for their work on the 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)	The author team has addressed these suggestions from the TSU.
37	54557	28	0	0	0	0	EXECUTIVE SUMMARY: Thank you for developing an initial draft of an Executive Summary for the FOD. For the SOD, the author team should focus on constructing assessment findings of the form employed by other chapters. Each paragraph should present an assessment finding in bold with calibrated uncertainty language, followed by additional nonbold sentences providing further explanation and context, as well as line of sight (a draft of which you already have provided) to supporting chapter sections where the traceable account appears. In the next round of revisions, I also suggest considering ways to make the Executive Summary findings more specific. Currently, the findings tend to the general, providing indications of directions of change when more specific/quantitative information is sometimes presented in the corresponding chapter text and sometimes providing less information about sub-regional differences. Please consider opportunities to include further detail while still providing clear findings. Specific comments that follow point out some of these opportunities, but please consider this more broadly as well. (Michael Mastrandrea, IPCC WGII TSU)	The Executive Summary has been reworked for the SOD with these review comments in mind.
38	54558	28	0	0	0	0	TRACEABLE ACCOUNTS: The author team has made a good start to providing traceable accounts for assessment findings and highlighting the location of those traceable accounts in the Executive Summary. Some specific comments follow where improvements could be considered. In general, I would recommend the author team continue to strengthen the linkage between support in the chapter text and assessment findings in the Executive Summary. In this context, I suggest providing some explanation of the calibrated uncertainty language used in the Executive Summary in the corresponding chapter section(s) where the traceable account appears for each finding, for cases where this is not done already. For example, in situations where confidence is not high, it would be useful to understand why the author team has made this judgment (e.g., is there a lack of robust evidence?, are there multiple perspectives in the literature?). In situations where confidence is high or likelihood language is employed, what is the evidence that forms the basis for these assignments? Succinct descriptions in the chapter text of this type will both highlight the basis for ES findings and help explain the author team's assessment of the literature. We in the TSU are available to discuss these issues as well if that would be of use. (Michael Mastrandrea, IPCC WGII TSU)	The Executive Summary has been reworked with these points in mind.
39	54906	28	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-Chap28_Reference Checks.pdf at https://ipcc-wg2.gov/AR5/author/FOD/SuppMat (Monalisa Chatterjee, IPCC WGII TSU)	References have been updated, checked and submitted
40	35494	28	1	0	0	0	ACIA referenced inconsistently not in list of references. Recommended citation is: ACIA, 2005. Arctic Climate Impact Assessment. Cambridge University Press, 1042 p. (Morten S. Olsen, Danish Energy Agency)	ACIA now in references
41	35495	28	1	0	0	0	SWIPA 2011 cited incorrectly and not in list fo references. Citation should be: AMAP, 2011. Snow, Water, Ice and Permafrost in the Arctic (SWIPA): Climate Change and the Cryosphere. Arctic Monitoring and Assessment Programme (AMAP), Oslo, Norway. xii + 538 pp. (Morten S. Olsen, Danish Energy Agency)	SWIPA now in references
42	35497	28	1	0	0	0	References to SOAC, ACCE, SASOCS are not found in list of references. (Morten S. Olsen, Danish Energy Agency)	The policy on acknowledging the other assessment reports is not to refer to them directly in the text but instead acknowledge their existence and key findings in the dedicated section at the beginning of the chapter. Elsewhere in the text efforts should be made to referencing the original publications.
43	48955	28	1	49	0	0	Please include the following UN reports: Study on the Impacts of Land Use Change and Climate Change on ... www.scribd.com/.../Study-on-the-Impacts-of-La... U.N. report sees climate among the forces ending herders' home on ... www.climateneeds.umd.edu/climatewire.../article... UN Report on Reindeer Husbandry and Climate Change Now ... icr.arcticportal.org/index.php?...reindeer...climat... (Svein Disch Mathiesen , International Centre for Reindeer Husbandry)	We are now required to eliminate references, rather than add. Unless a reviewer can specify where to add the reference and if it is very recent, we cannot add it

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
44	41803	28	2	16	0	21	<p>Considering the rapidly increasing role of tourism as an economic sector throughout the Arctic it is very curious that there is not a section discussing the sector. In particular, ongoing climate change has increased the prevalence of cruise tourism throughout Greenland, Norway, Alaska and Canada because of decreasing sea ice extent (along with other interacting non-climatic factors). Cruises through the Northwest Passage have increased by 70% since 2005 and total cruise itineraries in Arctic Canada have increased by 114% since 2005. In Greenland cruise itineraries have increased by 178% in the same timeframe. This omission is even more surprising considering that on page 30, lines 26 to 28 tourism is listed as one of the economies in the "formal sector" - see "Outside of the urban areas indigenous people often mix activities of the formal sector (e.g. commercial fish harvesting, oil and mineral resource extraction, forestry, and tourism) with traditional or subsistence activities, which include harvesting a variety of natural renewable resources to provide for human consumption". Many commentators are concerned with the perception that Arctic regions (in particular the Northwest Passage) are becoming increasingly 'safe' for cruise and pleasure craft boats when in fact the breaking up of multi-year sea ice has actually caused increased risk (this is in addition to the fact that many areas in the Arctic are not adequately charted for a variety of reasons including the fact that many areas were previously covered with multi-year ice). Thus, tourism clearly warrants a dedicated section here. There are several papers that discuss the implications of climate change for Arctic tourism which could be used to address this major gap. Here are just some that I am aware of: Stewart, E. J., Howell, S. E. L., Draper, D., Yackel, J. & Tivy, A. (2007). Sea ice in Canada's Arctic: Implications for cruise tourism in the Northwest Passage. <i>Arctic</i>. 60 (4) 370-380; Stewart, E. J., Howell, S. E. L., Dawson, J. D., Tivy, A. & Draper, D. Cruise tourism and sea ice in Canada's Hudson Bay region. <i>ARCTIC</i>. (63) 57-66 Arctic Institute of North America; Stewart, E.J., Dawson, J., and Johnston, M.J. (2012). Sea ice change and cruise tourism in Arctic Canada's Northwest Passage: Implications for local communities. <i>Polar Geography</i>; Dawson, J., Maher, P., and Slocombe, D., S. (2007). Climate change, marine tourism and sustainability in the Canadian Arctic: contributions from systems and complexity approaches. <i>Tourism in Marine Environments</i>. 4(2/3), 69-83; Dawson, J., Stewart, E.J., Maher, P.T., and Slocombe, D.S. (2009). Climate change, complexity and cruising in Canada's Arctic: a Nunavut case study. Invited chapter, (414-439) In R.B. Anderson & R.M. Bone, (eds) <i>Natural Resources and Aboriginal People in Canada</i>, 2nd ed., Captus Press, Concord, ON; Dawson, J. Stewart, E.J. Lemelin, H. and Scott, D. (2010). The carbon cost of polar bear viewing in Churchill, Manitoba, Canada. <i>Journal of Sustainable Tourism</i>, 18(3), 319-336; Dawson, J. Stewart E. and Scott, D. (2010). Climate change and polar bear viewing: a case study of visitor demand, carbon emissions and mitigation in Churchill, Canada. Invited chapter, (88-103) In: C.M. Hall and J. Saarinen, <i>Tourism and Global Change in Polar Regions</i> (eds), Routledge: New York; Stewart, E.J., Dawson, J., and Lemelin, R.H. <i>The Transformation of Polar Bear Viewing in the Hudson Bay Region, Canada</i>. (89-102). In Lemelin, H., Dawson, J., and Stewart, E. J. (2012). <i>Last Chance Tourism: adapting tourism opportunities in a changing world</i>. London: Routledge; Stewart, E.J., Draper, D. and Dawson, J. (2010). Coping with change and vulnerability: a case study of resident attitudes toward tourism in Cambridge Bay and Pond Inlet, Nunavut, Canada. Invited chapter, (33-53) In: P.T. Maher, E.J. Stewart, and M. Luck (eds), <i>Polar Tourism: Human, Environmental and Governance Dimensions</i>. Cognizant Communications Corp.: Elmsford, NY. Chapter 3; Stewart, E., Draper, D. and Dawson, J. (2010). Monitoring patterns of cruise tourism across Arctic Canada. Invited chapter, (133-145) In, M. Luck, P.T. Maher, and E.J.; Stewart (eds), <i>Cruise Tourism in Polar Regions: Promoting Environmental and Social Sustainability</i>. Earthscan: London. Chapter 9; Stewart E.J., and Dawson J. (2011). A matter of good fortune? The grounding of the Clipper Adventurer in the Northwest Passage, Arctic Canada. <i>Arctic</i> 64(2) 1-4 (June); Stewart, E.J., Dawson, J., and Draper, D. (2011). Cruise-ship tourism in Nunavut, Arctic Canada: An analysis of resident perspectives. <i>Journal of Hospitality and Tourism Management</i>, 28(4), 388-404; Johnston, M.E., Viken, A. and Dawson, J. <i>Firsts and lasts Arctic tourism: last chance tourism and dialectic of change</i>. (10-24) In Lemelin, H., Dawson, J., and Stewart, E. J. (2012). <i>Last Chance Tourism: adapting tourism opportunities in a changing world</i>. London: Routledge; Dawson, J., Johnston, M.E., Stewart, E.J., Lemieux, C.J., Lemelin, R.H., Maher, P.T. and Grimwood, B. (2011). Ethical dimensions of last chance tourism. <i>Journal of Ecotourism</i>. 10(3), 250-262. (Daniel Scott, University of Waterloo)</p>	<p>Due to strict space limitations Tourism has not been included. Tourism is well covered in the SWIPA report.</p>
44.2	41803	28	2	16	0	21	<p>Executive Summary I think this is poorly organised and lacks clarity. It did not follow the layout of the sections and I think it might be better if it did. Thus, for example, the 2nd and 3rd paragraphs talk about Arctic oceanography and marine ecosystems and then we move on to terrestrial ecology (both regions) and then to lakes (both regions) and then back to Antarctic oceanography and marine ecosystems (but with a couple of references to the Arctic). The paragraphs on Arctic and Antarctic Oceanography and Marine Ecosystems should follow each other, and the two on the Antarctic should, I think be changed. (Erica Head, Fisheries and Oceans Canada)</p>	<p>The Executive Summary has been reworked for the SOD.</p>
45	37243	28	2	34	0	0	<p>Executive Summary -- The chapter team has prepared a strong 1st-order draft executive summary. In revision, the chapter team is encouraged to present the paragraphs of the executive summary with a key finding in bold text followed by explanatory non-bold text. For each key finding and wherever else relevant, the author team should continue to use calibrated uncertainty language to characterize its degree of certainty in these conclusions. (Katharine Mach, IPCC WGII TSU)</p>	<p>The Executive Summary has been reworked for the SOD.</p>

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
47	49215	28	2	36	4	27	We are surprised not to find one single explicit reference to the IPY 2007-2009 in this chapter, while there are multitude of references to ACIA (2005) and AR4. Please add at least a reference to one of the synthesis reports, e.g. IPY Joint Committee Understanding the Earth's Polar Challenges: International Polar Year 2007-2008, summary by the IPY Joint Committee, February 2011. Edmonton, CN: CCI Press, xxiv, 695 p. ISBN: 9781896445557. Taken into account the hundreds of research papers that have been published on polar regions since the AR4, we regret that it has not been possible in the AR5 Executive summary to communicate more clearly what the key problems in respective areas, and which key factors we need to focus on in order to mitigate these problems. We propose to add a figure highlighting the key challenges and opportunities in the Arctic and the Antarctic respectively in the Executive summary to communicate these findings more clearly. For example does the chapter seem to indicate that extreme events, loss of sea ice and acidification are key problems at least in the Arctic, while introduction e.g. of non-local species threaten the Antarctica. Since extreme weather events are discussed e.g. on page.23. line 43, it could be worthwhile to add a reference to the SREX. We also propose to elaborate more on what we know about non-linear responses and multiple stress factors in the executive summary. (Oyvind Christophersen, Climate and Pollution Agency)	The policy on acknowledging the other assessment reports is not to refer to them directly in the text but instead acknowledge their existence and key findings in the dedicated section at the beginning of the chapter. Elsewhere in the text efforts should be made to referencing the original publications. the diagrams will be strategically used if space permits.
48	54559	28	2	38	2	38	Section 28.2.5.1 should be 28.2.5 (the former does not exist). (Michael Mastrandrea, IPCC WGII TSU)	Acknowledged
49	54560	28	2	38	2	40	These statements require a more specific reference to a specific location in AR4 WG2. The rationale for their placement in the Executive Summary is also unclear. If they are being presented as findings that the author team is reaffirming based on their assessment, the Executive Summary should reference relevant discussion in the chapter text rather than AR4. If they are just reiterations of AR4 findings, I would suggest shifting them to a discussion of past findings in the chapter text. (Michael Mastrandrea, IPCC WGII TSU)	Reference to the AR4 has been removed from the Executive Summary
50	35410	28	2	40	0	0	It's fairly weak to cite IPCC AR4 WGII in the first paragraph (David Vaughan, British Antarctic Survey)	Acknowledged
51	35411	28	2	40	0	0	This sentence is so amorphous that, without an example, it has almost no meaning to me (David Vaughan, British Antarctic Survey)	Acknowledged
52	36617	28	2	42	2	42	This statement is not strictly true. Strove et al (2007) who is cited on page 10 line 15, remarks that 4 models do represent well the observed rate of decline of Arctic sea ice. Change this statement to 'most models'. (Jeff Ridley, UK Met Office)	The summary now refers to the findings of Working Group 1.
53	51753	28	2	42	2	47	The author team may wish to consider several potential clarifications in revising this paragraph. 1st, on line 42, is it possible to specify more precisely the high "rate" of decline? 2nd, if it can be done concisely, it may be preferable to indicate slightly more specifically where and in what form "dramatic impacts on natural and social systems" would be anticipated. (Katharine Mach, IPCC WGII TSU)	noted. Efforts will be made to identify and eliminate the pieces of the text that fall into the WG-1 domain.
54	35416	28	2	43	0	0	Careful with the word similar here. Only in regional areas are the rates of change similar in the Antarctic (David Vaughan, British Antarctic Survey)	noted. Efforts will be made to identify and eliminate the pieces of the text that fall into the WG-1 domain.
55	36618	28	2	43	2	45	This statement implies that the Antarctic sea ice is changing in response to global warming. This is not the case as indicated in WG1 Ch14. The changes west of the Antarctic Peninsula are likely associated with the ozone hole and hence not caused by CO2. The rapid changes in Antarctica are associated with the ice sheet and ice shelves. Characteristics that do not feature elsewhere in this chapter. (Jeff Ridley, UK Met Office)	noted. Efforts will be made to identify and eliminate the pieces of the text that fall into the WG-1 domain.
56	54561	28	2	45	2	45	Please provide a more specific reference to the relevant chapter of WG1 AR5. (Michael Mastrandrea, IPCC WGII TSU)	noted. Efforts will be made to identify and eliminate the pieces of the text that fall into the WG-1 domain.
57	37581	28	2	45	2	47	The stated confidence in the sentence is too low, in my professional opinion. After four year of working on the AKSIK project (www.aksik.org) we have found that the rate of change is definitely a key factor in the ability of the Alaskan villages we study to adapt. (Jon Rosales, St. Lawrence University)	This is higher confidence level in edited, new version of E.S.
58	54562	28	2	45	2	47	The traceable account for this statement is not clear, as these points are not discussed explicitly in the section referenced. (Michael Mastrandrea, IPCC WGII TSU)	Noted
59	49216	28	2	45	2	48	It is also worth exemplifying how the rate rather than the magnitude of change might become a key factor (high confidence). Now it is just stated that there are some examples. (Oyvind Christophersen, Climate and Pollution Agency)	efforts will be made to search the literature for more examples
60	54563	28	2	47	2	48	Please provide line of sight to the traceable account for this statement. In addition, it would be useful to clarify what examples and what processes are meant here, as this is unclear. (Michael Mastrandrea, IPCC WGII TSU)	noted
61	54564	28	3	4	3	5	This statement is assigned "very high confidence" in the corresponding chapter text, which could be included here. It would also be useful to be more specific regarding the relevant timeframe for this change as well as others mentioned in this paragraph. (Michael Mastrandrea, IPCC WGII TSU)	Statement has been assigned "very high confidence" in SOD text.
62	51754	28	3	4	3	8	Potential clarifications for this paragraph could include the following. For the 1st sentence, is it possible to indicate more specifically the nature of the substantial increase--of what magnitude in terms of geographic area or rate of increase, over what time frame, etc.? Then, if "very likely" on line 5 is being used per the uncertainties guidance for authors (reflecting a probabilistic basis for its assignment), it should be italicized; casual usage should be avoided. Finally, it may be helpful to clarify further why the movement of the tree line, as described on lines 6-7, does not reflect circumpolar expansion. (Katharine Mach, IPCC WGII TSU)	Noted

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
63	40968	28	3	8	3	10	This comment does not refer specifically to tundra as the text but the northern boreal (taiga)- Other factors that are effecting changes in treeline - often restricting colonization of some species include genetic adaptation to the diurnal cycle (example species or populations of a species are not adapted to the long daylight hours- I would draw your attention to the work of Scott GREEN AND COLLABORATORS greens@unbc.ca) and various factors effecting regeneration following fires including more arid conditions and loss of seed sources as a result of hotter fires that are destroying seed sources (Jill Johston and collabroators jill.johnstone@usask.ca or http://homepage.usask.ca/~jfj445/) (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	Acknowledged.
64	44664	28	3	9	0	10	Not mentioned: The EU Arctic Footprint and Policy Assessment Project (Maria Ananicheva, Institute of Geography)	we are not acknowledging projects in this report
65	51755	28	3	12	3	12	Is it possible to specify more precisely the primary types of impacts observed for terrestrial and freshwater ecosystems to date? (Katharine Mach, IPCC WGII TSU)	Various impascts are addressed in the text as reflected in the supportiung original publications.
66	35417	28	3	17	0	0	"maritime Antarctic lakes", the phrase means nothing to me. (David Vaughan, British Antarctic Survey)	definition more clearly given
67	51756	28	3	17	3	19	For the 1st sentence of this paragraph, can the relevant time frame be indicated more specifically? For the 2nd sentence, is it possible to indicate the approximate magnitude or extent of the increases in phytoplankton levels? (Katharine Mach, IPCC WGII TSU)	detail provided as available
68	54565	28	3	17	3	20	Again, please specify timeframes for these changes. (Michael Mastrandrea, IPCC WGII TSU)	Exact timeframes not available
69	41958	28	3	18	3	18	"...warmed the lakes during winter" I suggest to change to "... increased lake water temperature during winter" (Vladimir Romanovsky, University of Alaska Fairbanks)	Accepted
70	51757	28	3	23	3	25	It would be helpful to clarify if this statement reflects changes that have been observed or if it instead characterizes responses that would be expected based on the understanding of mechanisms, physiology, etc. (Katharine Mach, IPCC WGII TSU)	detail appropriate to the area is provided
71	54566	28	3	23	3	28	Please expand the line of sight reference to the traceable account for all the statements in this paragraph. For example, sections 28.2.2.2 and 28.3.3.3 are also relevant. (Michael Mastrandrea, IPCC WGII TSU)	detail appropriate to the area is provided
72	35419	28	3	28	0	0	I understand the remit of the chapter, but a major advance since AR4 that might be material for the Ex Summary, is the understanding that the substantial rates of ice loss from the Amundsen Sea sector of the West Antarctic ice sheet is a climate-driven change, directly caused by oceans, and possibly indirectly by atmospheric climate change (via winds). citation: Pritchard, H. D., Ligtenberg, S. R. M., Fricker, H. A., Vaughan, D. G., van den Broeke, M., and Padman, L.: Antarctic ice loss driven by ice-shelf melt, Nature, 484, 502-505, 2012. (David Vaughan, British Antarctic Survey)	This is WG1 domain
73	54567	28	3	30	3	32	Please check the line of sight reference, as the traceable account does not appear in the section cited. (Michael Mastrandrea, IPCC WGII TSU)	Noted
74	51758	28	3	31	3	31	If "likely" is being used here per the uncertainties guidance for authors (reflecting a probabilistic basis for its assignment), it should be italicized. Casual usage of this reserved likelihood term should be avoided. Additionally, it would be helpful to clarify more specifically what is meant by "greatest threat"--greatest threat in what way? (Katharine Mach, IPCC WGII TSU)	Noted
75	37244	28	3	34	0	0	"Environmental changes and ecosystem responses in the marine environment etc". This entire paragraph was bit vague and I think the reference to section 28.3.2 (which deals with "Key Projected Impacts etc") should have been instead to section 28.2.2 (which is concerned with "Observed changes etc."). I would recommend omitting the 2nd and 3rd sentences, and combing this paragraph with the one that follows it, and I'd like to see a little more specificity. Thus, for example, "The reduction in sea-ice (extent and duration) appears to have resulted in enhanced primary production in the Arctic, whereas the earlier southerly retreat and reduced winter extent in the Antarctic have led to ???" – well – I don't know - what has happened to the phytoplankton? I couldn't find anything in the text that said anything about changes in (for example) the timing of the pelagic bloom, the overall level of primary production or phytoplankton composition in the Antarctic. I can't believe this is the state of our knowledge. Also, I would like to suggest that the Arctic and Antarctic parts of section 28.2.2 and 28.3.2 (and the parts of the Executive summary based on them) be structured in a somewhat similar way – starting with oceanography (including sea-ice extent and duration, temperature etc) then going to primary production (ice-algal + pelagic), then to secondary production and then to higher trophic levels. For each trophic level there are direct effects climate change, e.g. reductions in ice-cover, increasing temperatures and (sometimes) OA – and (sometimes) indirect effects. (Erica Head, Fisheries and Oceans Canada)	This paragraph was shortened and the chapter sections on the marine environments now clarifies key impacts.
76	44665	28	3	34	0	0	To add about glaciers and ice caps: for ex, " the largest and most permanent bodies of ice in the Arctic – multi-year sea ice, mountain glaciers, ice caps and the Greenland Ice Sheet - have all been declining faster since 2000 than they did in the previous decade (from SWIPA) (Maria Ananicheva, Institute of Geography)	This is WGI domain
77	35418	28	3	36	0	0	Please don't use Western Antarctic Peninsula like this, it's not a formal placename, and just confuses with West Antarctica (which is). Replace all occurrences with "west Antarctic Peninsula", or better, "west coast/side/etc of the AP" (David Vaughan, British Antarctic Survey)	terms have been clarified.
78	54568	28	3	36	3	38	Please be more specific in these statements. How have ecological communities responded? What ecological effects have occurred and how are they different? (Michael Mastrandrea, IPCC WGII TSU)	We clarified how climate changes have impacted or is projected to impact marine ecosystems.
79	51759	28	3	36	3	39	For these statements, it would be helpful to specify the overall timeframe relevant (also noting that they seem to describe observations, whereas 28.3 states a focus on projections). Additionally, it would be helpful to further clarify what is meant by "have responded" on line 36--have responded in what way? Also, is it possible to indicate more specifically what is meant by "direct but different ecological effects" and "will also differ"? (Katharine Mach, IPCC WGII TSU)	text was shortened and restructured to clarify points.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
80	54569	28	3	41	3	42	Again, please be more specific. What measurable changes? (Michael Mastrandrea, IPCC WGII TSU)	To the extent possible the measured changes and the time frame for observed changes were added.
81	51760	28	3	41	3	44	For the 1st statement in this paragraph, it would be helpful to clarify the relevant time frame. On line 43, is it possible to indicate the nature of the linkage between krill production and sea ice extent/duration--presumably the nature of the linkage has been a decrease in krill production? On the same line, can the "sea ice changes" be specified more precisely? Also, if "likely" is being used per the uncertainties guidance for authors (reflecting a probabilistic basis for its assignment), it should be italicized; casual usage of this reserved likelihood term should be avoided. (Katharine Mach, IPCC WGII TSU)	Noted
82	44666	28	3	43	0	0	To add (may be, by some edition): The recent acceleration of mass loss from mountain glaciers and ice caps in the Arctic is such that, together with the Greenland Ice Sheet, they are likely to account for more than 60% of the current glacier wastage contribution to global sea level rise. Glacier wastage is likely to increase inputs of freshwater, sediment, and some nutrients to Arctic coastal waters, with potential impacts on water mass circulation, biological productivity, and ecosystem structure in affected fjord and nearshore marine environments. (the source SWIPA-Chapter Glaciers and ice caps) (Maria Ananicheva, Institute of Geography)	This is WG1 domain
83	51761	28	3	46	3	50	For the opening sentence of this paragraph, it would be preferable to indicate the relevant time frame intended and the drivers that are relevant aside from climate change. For the changes described for Penguins, it would be also helpful to indicate the timeframe. (Katharine Mach, IPCC WGII TSU)	Summary detail is be provided where possible
84	42883	28	3	49	0	0	I question whether our knowledge of changes in penguin is medium, I would argue that changes in Penguin populations are well known and across the Antarctic they are declining in association with physical changes, thus High confidence (Daniel Costa, University of California Santa Cruz)	Noted but a difficulty in understanding penguin populations is relating trends in colonies to trends in overall populations. At present, it is not uniform within an area or across the Antarctic. This is being clarified at present.
85	54570	28	3	50	3	51	What multiple stressors are relevant to determining these trends? (Michael Mastrandrea, IPCC WGII TSU)	a short discussion of multiple stressors was added
86	37582	28	3	53	3	54	As with the entry above, the stated confidence is too low and should be "very high confidence." This is not only my professional opinion but that of most presenters at the International Polar Year 2012 conference in April held in Montreal who presented on the impacts of climate change on indigenous peoples in the Arctic in all circumpolar countries. (Jon Rosales, St. Lawrence University)	Confidence level developed by lead authors
87	37583	28	3	54	4	6	Loss or compromised freshwater sources and flooding to the list of impacts. For a source on flooding (and erosion) see: the U.S. General Accounting Office's report: Alaska Native Villages Limited Progress Has Been Made on Relocating Villages Threatened by Flooding and Erosion GAO-09-551, Jun 3, 2009. Available at: http://www.gao.gov/products/GAO-09-551 (Jon Rosales, St. Lawrence University)	This reference was added into the corresponding text in section 28.2.4 (could not be referenced in Executive Summary as no references were cited in E.S.). Edited text was sent along with new reference for bibliography on 1/21/13 to Joan . Is now in latest draft chapter
88	40969	28	4	4	4	5	For a number of logical reasons a large percentage of northern settlements are along coastlines or beside rivers and lakes. This makes them vulnerable to storms, ice changes and changes in water levels in addition to the associated permafrost and erosion issues referred to. Sea level in some areas is also affected by isostatic rebound as a result of historical loss of ice sheets. (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	Suggested words added to both Executive Summary and Introduction.
89	54571	28	4	9	4	9	As above, the inclusion of a reference to AR4 WG2 is unclear here. If the point is that this builds on conclusions from AR4, then this should be discussed in a section of the current chapter, which should then be referenced here. (Michael Mastrandrea, IPCC WGII TSU)	The reference to AR4 WG2 has been removed
90	51762	28	4	11	4	15	The author team may wish to consider phrasing on these lines. If changes described have not been formally attributed to climate change, the author team may consider more qualified wording accordingly. (Katharine Mach, IPCC WGII TSU)	They have been attributed to climate change – text fine as is
91	40970	28	4	11	4	20	Also the next paragraph- A number of issues including food security impacts al northern peoples- not just aboriginal populations though for many termed the "settler population" are not as culturally tied to traditional lifestyles making use of the resources from the ecosystems or what are often termed "country foods". Security of supply chains or developing technology that permits more local food production is being pursued by a large number of communities as part of adaptation strategies (and associated research institutes- as example Yukon Research Centre and Nunavut Research Institute both are engaged in testing and developing northern appropriate greenhouse technology, Yukon Research Institute is testing LCD Greenhouse lighting systems and bio char as aenhancement to what are typically poor northern soils). (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	Wording was modified in text to address this.
92	37584	28	4	13	0	0	As above, it is my professional opinion that there is very high confidence in this statement. (Jon Rosales, St. Lawrence University)	Taken into account in revision
93	44668	28	4	15	0	0	"To be certain, significant losses ≥25% can occur as the result of one or more successive events (Tyler, 2010; Bartsch et al., 2011)". This phrase is not clear, the loss of what? (should be clarified) (Maria Ananicheva, Institute of Geography)	Noted
94	44669	28	4	17	0	37	I did not understand why focus is ONLY given on reendeers in the Introduction part - Arctic. It is one of the problem, but there are a lot of others - climate change in Arctic, glaciers melting, sea level change, these points should be at least mentioned (Maria Ananicheva, Institute of Geography)	Most of what is noted falls into WG1 domain.
95	35412	28	4	28	0	0	I think it would be possible to craft a bullet for the Executive Summary that highlights the improved understanding of the mechanisms of climate change on the ice sheets for Antarctica and Greenland, with the increasing recognition of the direct role of the ocean. (David Vaughan, British Antarctic Survey)	Not included in SOD text.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
96	49217	28	4	32	4	43	Please make clear which definition of Polar regions this chapter uses. It is stated that you use the same as in ACIA and ACCE, but it is better to spell the definitions clearly out here. (Oyvind Christophersen, Climate and Pollution Agency)	Conventional IPCC definition is given on lines 32-34. As stated in the text (lines 39-43), we use it as a basis, while allowing a degree of flexibility when describing the regions in relation to particular subjects.
97	44670	28	4	34	0	0	Arctic - with capital letter (Maria Ananicheva, Institute of Geography)	Reviewer used wrong referencing of the text, in particular the word "Arctic" is not present at the indicated page/line. Meanwhile, spelling and capitalization will be checked throughout the entire text. Maria
98	44671	28	4	37	0	0	to mention the cosequences of the ice-free Arctic ocean for humans (shipping, gas and oil mining) and animals (bears), to metion also fast melting of ice caps and Greenland ice sheet and the impact - icebergs production, sea level change that caused threat for coastal human and natural systems (Maria Ananicheva, Institute of Geography)	Wrong referencing. The sentence in the line indicated by the reviewer gives definitions of the Arctic and Antarctic
99	51763	28	4	42	4	42	As a minor point, it would be helpful to clarify what is meant by "both" here--the Arctic and Antarctic? (Katharine Mach, IPCC WGII TSU)	"Yes, here ""both"" stands for the both polar regions, i.e. the Arctic and the Antarctic."
100	44672	28	5	0	0	0	To add somethere: Increased glacier melt may be associated with increased sediment loads, which would increase turbidity in coastal waters. Increased turbidity would reduce the penetration of solar radiation, including harmful UV-B radiation, with implications for primary production and ecosystem functioning. (Maria Ananicheva, Institute of Geography)	Noted. This has not been added to the Introduction because (1) the text has to be shortened, including the Introduction, which implies that messages have to be distilled: (2) the suggested statement is intuitively clear, but references to pier reviewed publications are needed to support it. Maria
101	40972	28	5	9	5	11	It would probably help readers if more major landscape or place names were added to these images so as to assist readers unfamiliar with the geography- sorry- I recognize the challenge that poses the authors (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	Noted. The figure will be redrawn at a later stage.
102	36661	28	5	13	5	18	The Arctic Report Card published in Nov. 2011 could be cited here as it presents an update to these other reports. (Sharon Smith, Geological Survey of Canada)	noted. Most of this text will be eliminated as the material does not fit into the scope of IPCC WG-2, including the physical changes in the sea ice extent and thickness, which falls into the WG-1 domain. On the other note, all internet-based resources, including the Arctic report card, may not be considered as a legal source of information in the IPCC report.
103	51764	28	5	17	5	18	For the statement, it might be helpful to clarify if this is an outcome projected across scenarios of climate and socio-economic development. Additionally, if "likely" is being used here per the uncertainties guidance for authors (reflecting a probabilistic basis for its assignment), it should be italicized; casual usage of this reserved likelihood term should be avoided. (Katharine Mach, IPCC WGII TSU)	Noted. The entire sentence was removed since it discusses the physical changes that are addressed in WG-1 report
104	35078	28	5	21	2	22	The terms "zonal" and "meridional" seem to be reversed here. Zonal refers to changes with longitude but the features the authors describe as varying zonally vary mostly with latitude and the features the authors describe as varying meridional vary mostly with longitude. (Kevin Arrigo, Stanford University)	Noted. Meanwhile, most of this text will be eliminated as the material does not fit into the scope of IPCC WG-2 and falls into the WG-1 domain.
105	39093	28	5	26	5	29	Extensive literature on climate-related shifts in Antarctic biota 1950s to 1990s in Ainley et al (2005) Antarctic Science 17, 171-182 should be cited (Eric Woehler, University of Tasmania)	noted. Generally, the IPCC policy is to cite monst recent publications after the previous report, i.e. papers published after 2007.
106	36662	28	5	31	5	38	Why is there no statement on Arctic terrestrial and freshwater realms? (Sharon Smith, Geological Survey of Canada)	Because these realms in the Arctic are much better understood than those in the Antarctic, which many readers consider as relatively uniform region.
107	35420	28	5	40	0	44	This statement is hard to swallow without specific examples. I think that the term "tipping point" is so conflicted that it is fairly toxic. Most of the "tipping points" that have been identified in primitive models, have later turned out to be reversible (AMOC) or hard to define (point of no-return for Greenland ice sheet). (David Vaughan, British Antarctic Survey)	The text has been deleted and the tipping points are not discussed anymore
108	52087	28	5	40	5	41	For the definition for "tipping point" here, it would be preferable to provide the definition from the glossary for the report. (Katharine Mach, IPCC WGII TSU)	The text has been deleted and the tipping points are not discussed anymore
109	49218	28	5	41	5	41	Please add a reference to the definition of t.p. (Oyvind Christophersen, Climate and Pollution Agency)	The text has been deleted and the tipping points are not discussed anymore
110	49219	28	5	47	5	37	IPY reports should be included (Oyvind Christophersen, Climate and Pollution Agency)	Papers that have been published under the IPY are cited in different sections of the chapter, i.e. the IPY results are reflected in the text.
111	36619	28	5	47	7	37	This section puzzles me. If there is scientific evidence in ACIA, SWIPA etc that is relevant to WG1 then this should be cited in the normal manner. To provide a summary of these as a separate synthesis seems out of place within the function of this chapter. (Jeff Ridley, UK Met Office)	The chapter has to follow the standardized structure, which contains the section summarizing the relevant knowledge from the previous reports. Efforts will be made to edit and shorten this section.
112	36663	28	5	49	5	53	There was also a considerable amount of research done during IPY (likely an increase in polar research) and this should also be mentioned. Also the annual Arctic Report Cards (and aslo State of Climate reports) should aslo be mentioned as they present annual updates on the state of the polar regions. (Sharon Smith, Geological Survey of Canada)	Noted. Papers that have been published under the IPY are cited in different sections of the chapter, i.e. the IPY results are reflected in the text. Arctic report card, as are other internet based resourses, is not referenced in the IPCC report.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
113	35496	28	6	0	0	30	suggested change: The Arctic Climate Impact Assessment Report (ACIA, 2005) and the synthesis report Snow, Water, Ice and Permafrost in the Arctic -SWIPA (AMAP, 2011)... (Morten S. Olsen, Danish Energy Agency)	Text changed as suggested
114	44673	28	6	1	0	0	(Hanelt et al., 2001; Erga et al., 2005). (Maria Ananicheva, Institute of Geography)	Comment out of place Maria
115	40971	28	6	4	7	6	I have been looking for some sense as to the human population, occupational patterns, use and cultural diversity of the arctic. I assumed it would be somewhere in this section or earlier. This is important because it influences both the nature or impacts on people and the challenges around adaptation. Likewise there should be something similar for the Antarctic in the next section - even though much (not all) of the human use is quite different. I recognize that changes in the polar regions impact more than just the ecosystems and "people systems" of the polar regions and this interconnectivity should also be mentioned. (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	Noted. Some of the reviewer's concerns are addressed in the current text, i.e. impacts on the Arctic society. Others are addressed in detail in the following sections.
116	41960	28	6	6	6	6	instead of "...has been warming" I would suggest "...has been increasing" (Vladimir Romanovsky, University of Alaska Fairbanks)	Text changed
117	51765	28	6	6	6	13	For this paragraph, several clarifications could be beneficial. 1st, for the warming described on line 6, it would be helpful to indicate more specifically what this high rate has been. 2nd, for the changes in sea ice described on line 9, the author team might consider indicating "baseline" values for the percentages given--that is, how do these current values compare to previous measurements? For the last sentence of the paragraph, it would be helpful to indicate if this is a projection relevant across climate/socio-economic scenarios; additionally, if "likely" is being used per the uncertainties guidance for authors (reflecting a probabilistic basis for its assignment), it should be italicized. Casual usage of this reserved likelihood term should be avoided. (Katharine Mach, IPCC WGII TSU)	Noted, the text was rewritten.
118	41962	28	6	6	6	54	This section failed to describe the impact of degrading permafrost on ecosystems and northern communities. Both ACIA and SWIPA discuss these impacts extensively. (Vladimir Romanovsky, University of Alaska Fairbanks)	Impacts of thawing permafrost on infrastructure have been added to this section.
119	37585	28	6	7	6	9	2011 sea ice decline is equivalent to 2007 (Jon Rosales, St. Lawrence University)	All numbers were updated given the new record breaking sea ice extent in 2012.
120	49220	28	6	10	6	10	less ice in the Arctic seas, more heat is absorbed which leads to further ... (Oyvind Christophersen, Climate and Pollution Agency)	Comment is not understood, very likely it falls into the WG1 domain.
121	35079	28	6	11	0	0	They use the term "albedo feedback" but it is more commonly referred to as the "ice-albedo feedback" (Kevin Arrigo, Stanford University)	text changed
122	51766	28	6	15	6	17	As can be supported by the underlying assessments, it would be helpful to indicate more specifically what is meant by "many levels," "new opportunities," and potentially "more vulnerable," perhaps providing very concisely key examples as appropriate. (Katharine Mach, IPCC WGII TSU)	Noted. The text has been substantially revised and efforts were made to give more specific examples
123	44674	28	6	16	0	0	To add - one of sources of river discharge increase for North-Esatern Siberia is melting of glaciers located over Chersky and Suntar-Khayata ranges (Maria Ananicheva, Institute of Geography)	Comment out of place
124	36664	28	6	16	6	16	A statement is made regarding new opportunities but there is nothing that follows in the paragraph that could be considered a discussion of opportunities but rather discusses challenges. Perhaps some examples of opportunities should also be given. (Sharon Smith, Geological Survey of Canada)	Noted. The text has been changed accordingly
125	41961	28	6	17	6	18	Loss of sea ice is not only one reason of coastal erosion. Another one, and probably more important, is degradation of permafrost. Furthermore, not only coastal communities are endangered. Many inland communities and big cities have similar and sometimes even more severe problems because of degradation of permafrost. (Vladimir Romanovsky, University of Alaska Fairbanks)	Noted. The text has been changed accordingly
126	43648	28	6	26	0	0	choose either adapt or adjust, not both (Marjut Kaukolehto, University of Helsinki)	Noted, text changed.
127	49221	28	6	26	6	26	adjust should be deleted (Oyvind Christophersen, Climate and Pollution Agency)	Noted, text changed.
128	51767	28	6	30	6	31	It would be beneficial to indicate the timeframe over which these changes have been observed. (Katharine Mach, IPCC WGII TSU)	The text describes the current changes as reported by these assessments. In this specific example baseline period of 1970s have been added to the sentence.
129	36665	28	6	35	6	36	One might argue that relocation is a form of adaptation. (Sharon Smith, Geological Survey of Canada)	We follow the convention of the preceding report, which considers relocation and adaptation as different options, i.e. adaptation is assumed to happen at the same place.
130	51768	28	6	35	6	37	It would be helpful to specify the timeframe meant by "the past"--over the cycles of ice ages, over the past few hundred years, etc.? On lines 35 and 37, if "very likely" is being used per the uncertainties guidance for authors (reflecting a probabilistic basis for its assignment), it should be italicized; casual usage of this reserved likelihood term should be avoided. (Katharine Mach, IPCC WGII TSU)	Noted. Text has been changed
131	37586	28	6	37	0	0	The term "terrestrial" should be inserted before the term "biodiversity." (Jon Rosales, St. Lawrence University)	Terrestrial is indicated in the first sentence on line 35.
132	36666	28	6	41	6	44	Note that in some countries (e.g. Canada), climate change is being incorporated into design of major resource development projects and therefore an important component of sustainable development. (Sharon Smith, Geological Survey of Canada)	this is in accord with what the text says.
133	36667	28	6	46	6	46	"affecting natural resources" Do you mean access to natural resources? (Sharon Smith, Geological Survey of Canada)	Text has been change to read "availability of natural resources"
134	36668	28	6	54	6	54	"local and coastal communities" Do you mean indigenous communities which is probably the more widely utilized term than local communities? (Sharon Smith, Geological Survey of Canada)	No, local communities include both indigenous and non-indigenous peoples. Inserted "indigenous" in front of "communities", delete "and coastal systems"

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
135	43649	28	7	0	0	0	Chapter 28.2. observed changes: the chapter is very long and with deeply evolving subsections. The clue is difficult to maintain. There is redundancy and some chapters even deal with the forcings and stressors rather than with effects as indicated in the chapter title (obs changes). I suggest to organise the text so that 28.2.3.8. - 28.2.3.10. could be independent second order chapters (i.e. 28.X.) earlier, and perhaps extract and move similar information (text related to human impacts, anthropogenic transfer and marine recovery) repeated in other sections to be included in these chapters. See also comment for page 36 for Chapter 28.2.7. related to this suggestion for reorganisation. (Marjut Kaukolehto, University of Helsinki)	noted. The chapter follows the standardized template and the structure can not undergo major revision. Efforts will be made to shorten the text and distill messages.
136	44675	28	7	1	0	37	Glacier lakes are missed, at least should be mentioned (Maria Ananicheva, Institute of Geography)	Comment out of place
137	36669	28	7	17	7	17	What about the reduction in incoming shortwave radiation that occurs when the ozone hole repairs? (Sharon Smith, Geological Survey of Canada)	This seems to be an issue in the WG-1 report, which addresses the physical changes in the climate system.
138	51769	28	7	17	7	17	The author team may wish to consider a more conditional framing here, for example, "If the ozone hole repairs over the next century as expected." (Katharine Mach, IPCC WGII TSU)	Text was rewritten and the "ozone story" deleted as not relevant to WG2.
139	35421	28	7	19	0	0	(ACCE, SASOCS (2009)) - Couldn't find the reference listed. I personally, don't think that the ACCE has the same level of peer-review that the SWIPA and ACIA reports had. It had lots of authors, but it was largely a text compiled by a small group from many contributions. It was not a consensus document. (David Vaughan, British Antarctic Survey)	Noted, although the mechanisms and links between the processes are well understood, and thus the statement in the text does not cause any doubt. The paragraph was shortened and most of the text on ozone was dropped as not relevant to WG2.
140	51876	28	7	40	0	0	Section 28.2. In further development of the chapter, the author team should consider overlap between parallel subsections of 28.2 and 28.3, reducing it as appropriate for the scope of each section. Overall, 28.2 and 28.3 would benefit from further distinction of observed impacts and vulnerabilities (treated in 28.2) and those projected for the future (assessed in 28.3). (Katharine Mach, IPCC WGII TSU)	Chapter has been edited, and overlaps have been addressed
141	37245	28	7	42	0	0	Section 28.2.1 Hydrology and freshwater ecosystems Surprisingly, I saw almost nothing about Arctic freshwater ecosystems – i.e. nothing about phytoplankton, zooplankton or fish. Are these covered in some other Chapter? If not, then this seems to be a gap that needs to be filled. There was a bit more about Antarctic freshwater ecosystems (phytoplankton), but not much. This is not my area of expertise, so I cannot suggest what should be included. If something on Arctic freshwater systems is to be included it should also appear in the Executive Summary (Erica Head, Fisheries and Oceans Canada)	New text about aspects of Arctic freshwater ecosystems (plankton/phytoplankton/...) has been added. References also included. An entry related to such has also been added to the Executive Summary.
142	39253	28	7	48	0	0	missing number in the brackets (1936-199_) (Thomas Voigt, Umweltbundesamt / Federal Environment Agency)	Missing number included: text now notes 1936-1999
143	43650	28	7	48	0	0	1936-199? What is the right year? (Marjut Kaukolehto, University of Helsinki)	Missing number included: text now notes 1936-1999
144	36620	28	7	48	7	48	replace 199 with 1999 (Jeff Ridley, UK Met Office)	Missing number included: text now notes 1936-1999
145	49222	28	7	48	7	48	Year is missing (1936-199?) (Oyvind Christophersen, Climate and Pollution Agency)	Missing number included: text now notes 1936-1999
146	51770	28	7	48	7	51	The year range on line 48 should be completed. Additionally, it would be helpful to clarify the implications of these statements-- does the lack of ability to attribute reflect other drivers, high levels of variability, etc.? (Katharine Mach, IPCC WGII TSU)	Missing number has now been included: text now notes 1936-1999. In terms of other drivers, the text expands to evaluate seasonal variations in flow and points to the main impediment of identifying the key drivers (e.g., permafrost effects, precipitation changes) on p. 8 L 16. We are unaware of other published literature that helps further identify controlling drivers.
147	36621	28	7	49	7	49	replace 1952 with 1951 (as per Milliman et al., 2008) (Jeff Ridley, UK Met Office)	Year corrected to be 1952.
148	36622	28	7	51	7	51	Drey and Wood, 2005 do not say anything about Canadian rivers and precipitation + this citation is not in the reference list (Jeff Ridley, UK Met Office)	The reference "Dery" and Wood (2005) has been added to the reference list. In reference to Canadian Rivers and precipitation, they note (citing from the abstract) "Freshwater discharge to high-latitude oceans in 64 Canadian rivers is investigated...data reveals a 10% decrease (125 km3/yr or 22 mm/yr) in the total annual river discharge to the Arctic and North Atlantic Oceans from 1964 to 2003. This trend in river runoff is consistent with a 21 mm/yr decline in observed precipitation over northern Canada between 1964 and 2000." The last line is believed to be supportive of the statement made.
149	51771	28	7	53	7	53	It would be helpful to also indicate the range of increases, besides this average value. (Katharine Mach, IPCC WGII TSU)	The range of change has been included for the 19 basins as well as how many were positive and negative. Text has also been modified regarding accelerating change. Text now reads: "More recent discharge data (1977-2007) for 19 circumpolar rivers indicates an area-weighted average increase of +9.8% (range -7.1 to +47.0%: 15 of 19 exhibiting increases), with additional evidence of accelerating change in recent years for the combined domain of six selected large basins (Overeem and Syvitski, 2010)."

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
150	36623	28	7	54	7	54	insert scentence which shows that such increases and acceleration can be attributed to increasing greenhouse gases (Wu, Wood & Scott (2005) Human influence on increasing Arctic river discharges, GRL, 32, L02703, DOI: 10.1029/2004GL021570) (Jeff Ridley, UK Met Office)	We agree that the Wu et al (2005) is a useful reference relative to the earlier literature, specifically that of Peterson et al. (2002) but the mandate of this IPCC 5th AR was to assess the new literature since the 4th AR. Unfortunatly, the Wu et al. (2005) does not consider the most recent data reported by, e.g., Overeem and Syvitski (2010).
151	51772	28	8	2	8	2	It would be helpful to also indicate the range of increases, besides this average value. Additionally, it would be helpful to clarify how this increase compares to the lack of increase described on line 8. Does the shift in timing described here not affect overall amount of flow? (Katharine Mach, IPCC WGII TSU)	Information about ranges by four regions has been included. Space limitations precludes discussion of all time periods analyzed but text now identifies the most recent 1961-2000 period as the one with the most pronounced change. Please see response to comment 152 in reference to changes in monthly/seasonal flow versus peak daily discharge. This should now be clearer in the text.
152	36624	28	8	8	8	8	This statement is contradicted by Tan et al., 2011 (Jeff Ridley, UK Met Office)	Tan et al., referenced on P.8, L6, focused on the timing of spring snowmelt. In their use of "fractional flow" values, they noted that "Fractional flow is used as a measurement for timing changes and is not necessarily indicative of changes in volume of annual streamflow." Despite this, they do suggest that via some of the timing measures (including CT) that there is, for example, increased spring runoff, and increased May flow. Their time-step, however, was seasonal and monthly, whereas the statement attributed to Shiklomanov et al. 2007 was about the magnitude of spring flow peaks: the analysis having been conducted on daily flow data to assess the potential for changes in floods. To avoid confusion in interpretation between the two findings about flows (monthly/seasonal and peak daily discharge) as well as include information about ranges in values requested in query #151, the text has been modified to say "Across the Russian Arctic drainage basin, dates of spring maximum daily discharge have also become earlier, particularly in most recent [1960-2001] period analyzed (average -5d: range for four regions +0.2 to -7.1 d), although no consistent trend exists for changes in the magnitude (average -1%: range +21 to -24%) of these daily flows (Shiklomanov et al., 2007). Changes to earlier timing were most pronounced in eastern, colder continental climates that have experienced rises in air temperature. Such upward trends in air temperature, rather than flow regulation, has been identified as the dominant control of such timing shifts (Tan et al., 2011)."
153	36670	28	8	8	8	10	Haven't these studies argued that increased winter minimum flows have been partly due to changing permafrost conditions and increased subsurface flow during winter? (Sharon Smith, Geological Survey of Canada)	Agreed and that is what was intended by the text referring to "enhanced groundwater inputs". To avoid confusion, this has been modified to say, as suggested, increased "subsurface flow".
154	41963	28	8	19	8	19	The word "lake," should not be there (Vladimir Romanovsky, University of Alaska Fairbanks)	Agreed that is superfluous and deleted.
155	41964	28	8	29	8	29	"organic" instead of "organ" (Vladimir Romanovsky, University of Alaska Fairbanks)	Typographical error has been corrected to "organic".
156	51773	28	8	29	8	50	"likely" on lines 29 and 50 -- 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)	Text has been modified to eliminate the likelihood term and now reads "...reductions in organic carbon burial has been attributed to a strong positive relationship with the mineralization of organic carbon in lake sediments..."
157	36671	28	8	33	8	40	Kokelj et al (2009), Lamoureaux & Lafreniere (2009), Dugan et al. (2009) are relevant to the discussion regarding changing water chemistry associated with changing permafrost conditions and landscape instability. Refs: Kokelj SV, Zajdik B, Thompson MS (2009) The impacts of thawing permafrost on the chemistry of lakes across the subarctic boreal-tundra transition, Mackenzie Delta region. Permafrost and Periglacial Processes 20:185-199 Lamoureaux SF, Lafrenière MJ (2009) Fluvial Impact of Extensive Active Layer Detachments, Cape Bounty, Melville Island, Canada. Arctic, Antarctic, and Alpine Research 41:59-68 (Sharon Smith, Geological Survey of Canada)	The authors appreciate the reference to additional literature. However, the IPCC has enforced strict page limits that also means a restriction on the number of references that can be included. Hence, even the current number in this FOD must be reduced. In this case, however, the Kokelj et al. 2009 has also been added because of its strong relevance to the point being made on L37.
158	49312	28	8	35	0	0	"ensemble" is climate-science jargon. Suggest replace with 2 or 3 words that say what it means for the general reader. (Graeme Pearman, Monash University)	The term is not used here. The point will be addressed in other sections if found, although the preferred option is to include this word in the overall Assessment glossary if deemed appropriate by the TSU of the IPCC.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
159	41965	28	8	35	8	35	What does "states/condition of the permafrost" mean? (Vladimir Romanovsky, University of Alaska Fairbanks)	For clarity, the text has been changed to indicated "thawing state of the permafrost"
160	43651	28	8	36	0	0	Correct the reference D. and Kirsten 2010, also in the references list. (Marjut Kaukolehto, University of Helsinki)	Reference has been corrected to be: Prowse, T.D. and Brown, K. 2010. Appearing and disappearing lakes in the Arctic and their impacts on biodiversity. In: Arctic Biodiversity Trends 2010 – Selected indicators of change. Eds: T. Kurvits et al. Conservation of Arctic Flora and Fauna International Secretariat, Akureyri, Iceland, p. 68-70.
161	49223	28	8	36	8	36	Incorrect reference (Oyvind Christophersen, Climate and Pollution Agency)	Reference has been corrected to be: Prowse, T.D. and Brown, K. 2010. Appearing and disappearing lakes in the Arctic and their impacts on biodiversity. In: Arctic Biodiversity Trends 2010 – Selected indicators of change. Eds: T. Kurvits et al. Conservation of Arctic Flora and Fauna International Secretariat, Akureyri, Iceland, p. 68-70.
162	36672	28	8	40	8	40	If Thompson et al is not accepted, it may need to be removed. (Sharon Smith, Geological Survey of Canada)	Thompson et al. has been published. The reference has been updated to: Thompson, M.S., Wrona, F.J. and Prowse, T.D. 2012. Shifts in plankton, nutrient and light relationships in small tundra lakes caused by localized permafrost thaw. Arctic, 66 (4): 367-376.
163	51774	28	8	43	8	43	It would be helpful to potentially specify a bit further what is meant by "dynamics" here. (Katharine Mach, IPCC WGII TSU)	The term "dynamics" has been replaced with "physical severity" to be consistent with the explanation of dynamics provided in Section 28.3.1.1,
164	44676	28	9	1	0	9	Antarctic is featured by subglacial lakes, most famous - Vistok lake, which is about to be reached by ice drilling, the unique ecosystem of the lake might be an discovery of the century. This point should be included (Maria Ananicheva, Institute of Geography)	at present, there is no literature on life in subglacial lakes and so difficult to include in a section on observed climate change impacts
165	49224	28	9	5	10	13	In this section I had expected at least one reference to publications by Ole Anders Nøst, Ole.anders.nost@npolar.no, e.g. http://www.npolar.no/en/research/ice/fimbul-ice-shelf/ (Oyvind Christophersen, Climate and Pollution Agency)	this work belongs in WG1
166	36625	28	9	24	9	25	"local climate increase of 2C" does not make sense. Suggest "local temperature rise of 2C" (Jeff Ridley, UK Met Office)	noted
167	49225	28	9	27	9	27	As a result chlorophyll concentrations. Please delete "a" (Oyvind Christophersen, Climate and Pollution Agency)	noted for revisions. The referred measurements relate to Chlorophyll a.
168	43652	28	9	37	9	43	How specific conductance reflects water balance? You could shortly clarify the process what you try to elaborate here. What specific conductance indicates? Ionic concentration, which increases along with drying conditions? This paragraph would benefit a summarising graph where you illustrate the variability. (Marjut Kaukolehto, University of Helsinki)	text clarified
169	49226	28	9	39	9	39	Please delete "repeate" (Oyvind Christophersen, Climate and Pollution Agency)	text clarified
170	51775	28	9	47	9	50	It would be preferable to specify the approximate time frame for these changes--all since the 1950s? (Katharine Mach, IPCC WGII TSU)	text clarified
171	44677	28	10	0	0	0	Seems to be a gap - impact of iceberg fast production and spread on marin ecosystems as well as oil mining on shelf (Maria Ananicheva, Institute of Geography)	Noted.
172	35422	28	10	2	0	0	This section does not really cover the multiple stressors for Antarctica as the title suggests. The main one is the flood of tourism and exponential growth in visitor numbers. The potential for alien species introduction is high and is reduced by good practice in the tourism industry, but it is still a significant risk. (David Vaughan, British Antarctic Survey)	text has been clarified
173	51776	28	10	9	10	9	Would it be preferable to use the phrase "climate change" instead of "global warming" here? (Katharine Mach, IPCC WGII TSU)	Comment accepted
174	36626	28	10	9	10	22	This introduction is poorly constructed. Marine ecosystems are influenced by changes in (i) primary productivity, (ii) species range shifts, (iii) zooplankton community size structure, (iv) ocean acidification, and (v) ocean deoxygenation. All of these are then influenced by changes in sea ice cover, river flow (neurients and contaminants) and vertical/horizontal mixing. (Jeff Ridley, UK Met Office)	This sentence was modified
175	36628	28	10	11	10	11	Rephrase this line as the timing and duration are delt with by WG1 Maslowski reference does not address the impact on the irradiance of the water column on marine ecosystems as do Wassmann and Stabeno.. (Jeff Ridley, UK Met Office)	We now reference WG 1 report.
176	36627	28	10	12	10	12	include reference to Stabeno et al, 2010 in brackets for preceeding references (Jeff Ridley, UK Met Office)	Accepted
177	51777	28	10	12	10	12	If it can be done concisely, it would be preferable to provide more of the reference finding from working group one here. (Katharine Mach, IPCC WGII TSU)	Accepted
178	39254	28	10	14	0	0	delete the term 'and' (Thomas Voigt, Umweltbundesamt / Federal Environment Agency)	Accepted
179	36629	28	10	15	10	15	Replace reference to Maslowski with (Kwok, R. and D. A. Rothrock (2009), Decline in Arctic sea ice thickness from submarine and ICESat records: 1958–2008, Geophys. Res. Lett., 36, L15501, doi:10.1029/2009GL039035) to deal with the thinning of the ice from observations (Maslowski uses a model). (Jeff Ridley, UK Met Office)	We now reference WG 1 report.
180	51778	28	10	20	10	20	"likely" -- If this term is being used per the uncertainties guidance for authors (reflecting a probabilistic basis for its assignment), it should be italicized. Casual usage of this reserved likelihood term should be avoided. (Katharine Mach, IPCC WGII TSU)	Accepted we used confidence language

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
181	42884	28	10	24	10	38	There is no mention of the effect of ocean acidification on food webs. We have no idea if there will be an effect. However, if primary producers or zooplankton are affected, then then the whole food chain will respond in ways that we can't predict. (Daniel Costa, University of California Santa Cruz)	A paragraph on ocean acidification was added.
182	35252	28	10	24	10	39	Some modelling has been conducted regarding acidification of the oceans in northern waters. A relevant example is found in: Bellerby GA, Olsen A, Furevik T & Andersson TG 2005. Response of the surface ocean CO2 systems in the Nordic Seas and Northern North Atlantic to climate change. In Drange H et al. (eds): The Nordic seas, an integrated perspective. AGU Geophysical Monographs. (Ellen Øseth, Norwegian Polar Institute)	A paragraph on ocean acidification was added.
183	51779	28	10	29	10	29	The author team may wish to consider specifying the timeframe, geographic extent, and essentially the socio-economic scenarios for such under saturation. (Katharine Mach, IPCC WGII TSU)	Socio-economic scenarios not available. Time frames and locations for observations were added
184	36630	28	10	40	0	0	A section is need here on the loss of oxygen due to methanotropes consuming methane released from the sea floor either from hydrates or biogenic sources (Hansen & Handsen, 1996; Elliott et al., 2010). This will impact on phytoplankton and upwards. reference to the basic issues of Methane release in WG1. Hanson, R., and T. Hanson (1996), Methanotrophic bacteria, Microbiol. Rev., 60, 439–471. Elliott, S., M. Reagan, G. Moridis, and P. C. Smith (2010), Geochemistry of clathrate-derived methane in Arctic ocean waters, Geophys. Res. Lett., 37, L12607, doi:10.1029/2010GL043369. (Jeff Ridley, UK Met Office)	This was not addressed due to page limitations.
185	35080	28	10	41	10	54	The authors may want to refer to a newer paper that demonstrates a 20% increase in primary production in the Arctic Ocean between 1998 and 2009. Reference: Arrigo, K. R. and G. L. van Dijken, 2011. Secular trends in Arctic Ocean net primary production. Journal of Geophysical Research, 116, C09011, doi:10.1029/2011JC007151. In addition, a more recent paper (Arrigo et al. 2012) demonstrates that massive phytoplankton blooms can develop beneath Arctic sea ice. This is a very new and unexpected discovery and has implications for the timing of sea ice production and its partitioning between pelagic and benthic ecosystems. It should be included here in some form. Reference: Arrigo, K. R., D. K. Perovich, R. S. Pickart, Z. W. Brown, G. L. van Dijken, K. E. Lowry, M. M. Mills, M. A. Palmer, W. M. Balch, F. Bahr, N. R. Bates, C. Benitez-Nelson, B. Bowler, E. Brownlee, J. K. Ehn, K. E. Frey, R. Garley, S. R. Laney, L. Lubelczyk, J. Mathis, A. Matsuoka, B. G. Mitchell, G. W. K. Moore, E. Ortega-Retuerta, S. Pal, C. M. Polashenski, R. A. Reynolds, B. Scheiber, H. M. Sosik, M. Stephens, J. H. Swift. 2012. Massive phytoplankton blooms under Arctic sea ice, Science, 336, 1408. (Kevin Arrigo, Stanford University)	This comment was accepted
186	51780	28	10	48	10	51	The author team should consider specifying the relevant timeframe of these changes. (Katharine Mach, IPCC WGII TSU)	Time frames and locations for observations were added
187	37246	28	10	52	0	0	“warmer ocean conditions will favour small phytoplankton over large phytoplankton” This is a bit misleading as written. Li et al. (2009) were looking at the Canada Basin in summer, after the spring bloom. The spring bloom would, undoubtedly, have been dominated by large phytoplankton. So, the interpretation of Li et al is that warming will increase stratification and decrease nutrient supply to the surface layers, so that smaller phytoplankton win the competition for nutrients. Moran et al. (2010) find a higher proportion of small cells at higher temperatures, independent of nutrient supply. So, I suggest writing “warmer conditions in the Canada Basin in summer will lead to increasing stratification and reduced nutrient supply to the surface, and hence to an increasing contribution of smaller forms to the phytoplankton community (Li et al. 2009). The effect of warming elsewhere in the Arctic in spring and/or summer might be towards an increasing proportion of smaller cells (Moran et al. 2010), but additional observations would be required to confirm whether this is the case.” (Erica Head, Fisheries and Oceans Canada)	This comment was accepted

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
188	37247	28	11	2	0	0	<p>“Copepods () tend to dominate the Arctic . . .” Copepods do indeed dominate the Arctic, but otherwise this paragraph contains several misleading statements and some outright errors. Here are a few 1) “Calanus finmarchicus are common in the Barents Sea etc” This is misleading. C. finmarchicus are not endemic to the Barents Sea. They are not found there in the winter, because they overwinter at depths of >200 m, mainly in the nearby Norwegian Sea. They are found in the Barents Sea in spring/summer, but must be advected in each year. 2) “C. glacialis dominates the western shelf etc” C. glacialis are also found in several regions other than those mentioned in the text, e.g. the Central Arctic Ocean, Baffin Bay, the East Greenland Current, the Labrador Shelf etc. 3) “C. hyperboreus is a deep water species found in the Greenland Sea, Fram Strait, the Labrador Sea, the Baffin Sea and the Arctic Ocean Basin” C. hyperboreus are NOT common in the Labrador Sea, although they are quite abundant on the Labrador Shelf. They are also quite common throughout the shallow waters of the Canadian Arctic Archipelago. 4) “Metridia longa has been observed in the Beaufort Sea”. M. longa is also the most abundant copepod in the North Water Polynya in Baffin Bay and it is also common in the central Arctic Ocean and in the slope waters throughout the eastern Arctic. 5) “C. finmarchicus overwinters in deeper waters over the slope of the northeast Norwegian Sea” C. finmarchicus overwinters throughout the Norwegian Sea, but the biggest overwintering population of C. finmarchicus is probably the one that occupies the NW Atlantic sub-polar gyre, which covers the Labrador Sea and the Irminger Sea. 6) “C. hyperboreus undergoes diapause to save energy during the winter” All Calanus species spend some part of the year in diapause, and C. hyperboreus actually reproduces during the winter, expending the energy it has accumulated during the previous growth season. This is my area of expertise, so I have re-written this paragraph. “Copepods (small pelagic crustaceans) dominate the mesozoplankton community in the Arctic, where they are preyed upon by larger invertebrate predators, fish, seabirds and marine mammals. Four species of the genus Calanus are common, but only two, C. glacialis and C. hyperboreus, are true Arctic species (Conover 1988). The other two, C. finmarchicus and C. marshallae, are boreal ex-patriot species that are brought north in the Atlantic and Pacific water inflows, respectively. All four Calanus species feed on phytoplankton, accumulating lipid (wax-esters) during the growth season, and spending some part of the year dormant (in diapause) below the surface layers. All four have reproductive cycles that take advantage of the spring bloom in some way and while the boreal species have annual life cycles, the Arctic species take 2 or more years to mature and reproduce. Within the Arctic region C. glacialis tends to dominate in shelf/slope water regions (e.g. Barents Sea (Arashkevich et al. 2002), shallow Laptev Sea (Kosobokova et al. 1998)), while the much larger species, C. hyperboreus, is equally abundant, and much more important in terms of biomass, in deeper waters (e.g. Central Arctic Ocean (Thibault et al. 1999), Amundsen Basin (Kosobokova and Hirche 2009), Canada Basin (Hopcroft and et al. 2005)). Both species are equally abundant in the passages of the Canadian Arctic archipelago and Baffin Bay (Longhurst et al. 1984, Ringuette et al. 2002) and C. hyperboreus (but not C. glacialis) is also abundant in the Greenland Sea (Hirche 1997). Neither Arctic species is abundant in the deep waters of the Labrador and Norwegian seas, where C. finmarchicus is dominant (Head et al. 2003, Broms et al. 2009). C. finmarchicus can be very abundant in regions of the eastern Arctic that are influenced by Atlantic water (e.g. Davis Strait (Huntley et al. 1983), Fram Strait (Hirche et al. 1991), western Barents Sea (Tande 1991)), while in the western Arctic relatively few C. marshallae are transported into the Chukchi Sea through Bering Strait (Hopcroft et al. 2010). Other important large-bodied copepods are Neocalanus cristatus and N. flemingeri in the Bering Sea (Conover 1988), which have life histories and feeding preferences similar to those of the Calanus species, and Metridia longa, which</p>	parts of this comment were accepted, however due to page limitations the text was shortened.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
188.2	37247	28	11	2	0	0	is abundant throughout the deep waters of the eastern and central Arctic (Hirche and Mumm 1992, Ringuelette et al. 2002, Thibault et al. 2003, Kosobokova and Hirche 2009), and which is active all year round, feeding omnivorously." References not already in the reference list Arashkevich, E., P Wassmann, A. Pasternak and C. Wexels Riser. 2002. Seasonal and spatial changes in biomass, structure, and development of the zooplankton community in the Barents Sea. J. Mar. Sys. 38, 125-145 Broms, C., W. Melle and S. Kaartvedt. 2009. Oceanic distribution and life cycle of Calanus species in the Norwegian Sea and adjacent waters. Deep-Sea res. II 56, 1910-1921 Conover, R.J. 1988. Comparative life histories in the genera Calanus and Neocalanus in high latitudes of the northern hemisphere. Hydrobiologia. 167/168, 127-142 Head, E.J.H., L.R. Harris and I. Yashayaev. 2003. Distributions of Calanus spp. and other mesozooplankton in the Labrador Sea in relation to hydrography in spring and early summer (1995-2000). Prog. Oceanogr. 59, 1-30 Hirche, H.-J. 1997. Life cycle of the copepod Calanus hyperboreus in the Greenland Sea. Mar Biol. 128, 607-618 Hirche, H.-J. and N. Mumm. 1992. Distribution of dominant copepods in the Nansen Basin, Arctic Ocean, in summer. Deep-Sea Res. 39, Suppl. 2, 5485-5505 Hirche, H.-J., M.E.M. Baumann, G. Kattner and R. Gradinger. 1991. Plankton distribution and the impact of copepod grazing on primary production in Fram Strait, Greenland Sea. J. Mar, Sys. 2, 477-494 Hopcroft, R.R., K.N. Kosobokova. and A.I. Pinchuk. 2010. Zooplankton community patterns in the Chukchi Sea during summer 2004. Deep-Sea Res. II. 57, 27-39 Hopcroft, R.R., C. Clarke, R.J. Nelson and K.A. Raskoff. 2005. Zooplankton communities of the Arctic's Canada Basin: the contribution by smaller taxa. Polar Biol. 28, 198-206 Huntley M., K.W. Strong and A.T. Dengler AT. 1983. Dynamics and community structure of zooplankton in the Davis Strait and Northern Labrador Sea. Arctic 36,143-161 Kosobokova, K. and Hirche, H.-J. 2009. Biomass of zooplankton in the eastern Arctic Ocean – A base line study. Prog. Oceanogr. 82, 265-280 Kosobokova, K.N., H. Hanssen, H.-J. Hirche and K. Knickmeier. 1998. Composition and distribution of zooplankton in the Laptev Sea and adjacent Nansen Basin during summer, 1993. Polar Biol. 19, 62-76 Longhurst, A.L., Sameoto, D., Herman, A. 1984. Vertical distribution of Arctic zooplankton in summer: eastern Canadian archipelago. J. Plankton Res. 6, 137-168 Ringuelette, M., L. Fortier, M. Fortier, J.A. Runge, S. Belanger, P. Larouche, J.-M. Weslawski and S. Kwasniewski. 2002. Advanced recruitment and accelerated population development in Arctic calanoid copepods of the North Water. Deep-Sea Res. II. 49, 5081-5099 Tande, K.S. 1991. Calanus in North Norwegian fjords and in the Barents Sea. Polar Research. 10, 389-407 Thibault, D., E.J.H. Head, P.A. Wheeler. 1999. Mesozooplankton in the Arctic Ocean in summer. Deep-Sea res. I. 46, 1391-1415. (Erica Head, Fisheries and Oceans Canada)	
189	51781	28	11	2	11	53	For all material on this page, the relevance to climate change should be carefully considered, with background material not directly relevant deleted or substantially reduced in length. (Katharine Mach, IPCC WGII TSU)	We shortened the background information as much as possible.
190	43653	28	11	9	11	14	Is this detailed listing of species specific ecological behaviour relevant? Somehow it seems detached. (Marjut Kaukolehto, University of Helsinki)	We shortened the background information as much as possible.
191	35081	28	11	16	11	27	The massive under-ice phytoplankton blooms referred to above should be included in this paragraph as well. (Kevin Arrigo, Stanford University)	Accepted
192	44678	28	11	17	0	0	I suppose there should be a figure of sea ice extend variation in the Southern Ocean since the advent of satellite observation, might be taken from papers of Dave Bromwich, f.ex. (Maria Ananicheva, Institute of Geography)	Figures appear in WG 1 reports
193	37248	28	11	24	0	0	"In a future more productive Arctic Ocean etc" I would replace this sentence with "A future warmer and more productive Arctic Ocean could be beneficial to C. hyperboreus and C. glacialis in some areas and detrimental in others, although the lengthening of the growth season would probably be insufficient to allow C. finmarchicus or C. marshallae to become endemic species (Slagstad et al. 2011, Ji et al. 2012)." Reference Ji, R., C. J. Ashjian, R.G. Campbell, C. Chen, G. Gao, C. S. Davis, G.W. Cowles and R. C. Beardsley. 2012. Life history and biogeography of Calanus copepods in the Arctic Ocean: An individual-based modeling study. Prog. Oceanogr. 96, 40–56 Slagstad et al. 2011 is already in the Chapter reference list (Erica Head, Fisheries and Oceans Canada)	This sentence was modified

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
194	37249	28	11	34	0	0	"Factors that influence the water temperature etc" As far as I am aware euphausiids do not enter the Arctic from the Atlantic via Fram Strait, and the copepods that do (notably C. finmarchicus) are not advected into the Chukchi Sea and Beaufort Sea regions: the currents don't take them that way and I don't think they are expected to suddenly change direction with climate change. Also, the ideas in this paragraph were so poorly expressed that I re-wrote the whole thing. I think my version is better. Euphausiids (krill) are not endemic to the Arctic, but are brought into the region in the Atlantic and Pacific inflows. In the Barents Sea, krill (mainly Thysaessa inermis and T. raschii) provide an important food source for several species of fish, including cod, haddock and capelin (Dalpadado et al. 2009, Orlova et al. 2009, Ressler et al. in press). In the west, euphausiids are transported north through the Bering Strait towards the Beaufort Sea, where aggregations are consumed by bowhead whales off Point Barrow, Alaska (Berline et al. 2008). Climate-related changes in currents into and within the Arctic will likely change the abundance and distribution of euphausiids. For example, in the Barents Sea years with greater intrusions of Atlantic water give higher temperatures and higher levels of euphausiids, with varying species composition (Zhukova et al. 2009). References not already in the Chapter reference list Dalpadado, P., B. Bogstad, E. Eriksen and L. Rey. 2009. Distribution and diet of 0-group cod (Gadus morhua) and haddock (Melanogrammus aeglefinus) in the Barents Sea in relation to food availability and temperature. Polar Biol. 32, 1583–1596 Zhukova, N.G., V.N. Nesterova, I.P. Prokopchuk and G.B. Rudneva. 2009. Winter distribution of wuphausiids (Euphausiacea) in the Barents Sea (2000-2005). Deep-Sea Res. II. 56, 1959-1967 (Erica Head, Fisheries and Oceans Canada)	Some of this wording was accepted
195	51782	28	11	37	11	37	"likely" -- If this term is being used per the uncertainties guidance for authors (reflecting a probabilistic basis for its assignment), it should be italicized. Casual usage of this reserved likelihood term should be avoided. (Katharine Mach, IPCC WGII TSU)	Comment accepted confidence language was used.
196	37250	28	12	3	0	0	3 "Kenneth F., 2011" should be "Drinkwater, 2011" and the reference to Kenneth, F. D. 2011 should be removed from the list of references at the end of the Chapter: the correct Drinkwater reference is there (Erica Head, Fisheries and Oceans Canada)	This section was shortened.
197	37251	28	12	9	0	0	"Wassmann et al. 2011". Here and elsewhere, including the references at the end of the Chapter should be "Wassmann et al. 2010" (Erica Head, Fisheries and Oceans Canada)	Accepted
198	51783	28	12	25	12	27	The timeframe over which this correlation was observed could be clarified. (Katharine Mach, IPCC WGII TSU)	OK, Included
199	42885	28	12	38	0	0	Uria algae is spelled with only one a (Daniel Costa, University of California Santa Cruz)	Corrected
200	51784	28	12	39	12	43	The timeframe for the statements (the relevant decades for the thirty-year period, for example) could be clarified further. (Katharine Mach, IPCC WGII TSU)	OK, it is done
201	37252	28	12	53	0	0	"exceed the thermal preference of large copepods (Calanus), their main prey" The point is that the little Auks prefer the larger Arctic Calanus species (C. glacialis and C. hyperboreus) over the smaller boreal Calanus species (C. finmarchicus). So, I would replace this phrase with "exceed the thermal range suitable for their preferred prey, the large lipid-rich Arctic copepods Calanus glacialis and C. hyperboreus." (Erica Head, Fisheries and Oceans Canada)	OK it is corrected
202	51785	28	13	3	13	19	"likely" on lines 3 and 19, "very likely" on line 12 -- If this term is being used per the uncertainties guidance for authors (reflecting a probabilistic basis for its assignment), it should be italicized. Casual usage of this reserved likelihood term should be avoided. (Katharine Mach, IPCC WGII TSU)	Noted
203	51786	28	13	9	13	9	It would be helpful to provide further specifics on what is meant by "significant" here. (Katharine Mach, IPCC WGII TSU)	Noted
204	37253	28	13	27	0	0	There is nothing in this section about the potential effects of increased shipping/oil and gas development/fishing on seabirds in the Arctic. I don't know whether there should be, I am just pointing it out. (Erica Head, Fisheries and Oceans Canada)	Noted
205	36673	28	13	29	0	0	section 28.2.2.1.2 Polar Bears - Throughout this section there are a nuber of articles published prior to 2007 (some more than 20 years old). Are all these necessary as the focus should be on recent advances. (Sharon Smith, Geological Survey of Canada)	The vast majority of the references are from 2000 and beyond with coverage of all recent works. The older references are used for context and to make specific points that pertain to more recent works. I can, of course, remove some of the earlier papers and will do so if need be. No changes in this revision.
206	51787	28	13	29	0	0	Section 28.2.2.1.2. Throughout this section, the author team should use calibrated uncertainty language to characterize its degree of certainty in key findings, generally those supported by multiple lines of evidence. For the section as a whole, there may be one or several such key findings, and it may be clearest to reduce assignment of calibrated uncertainty language here accordingly. Additionally, all calibrated uncertainty language used here, including summary terms for evidence and agreement, levels of confidence, and likelihood terms, should be italicized. Finally, please note that the summary term for evidence should be "medium evidence," rather than "moderate evidence," where relevant. (Katharine Mach, IPCC WGII TSU)	"moderate evidence" has been replaced with "medium evidence", terms are now in italics.
207	40973	28	13	29	15	5	one theme alluded to near the end of this section is the use by polar bears of terrestrial habitats and the occurrence of bears well inland from what has historically been their traditional range (example Deline NWT). The other is the hybridization and potential competition with Grizzly bears and the possibility that the increased sighting of grizzly bears on habitat that historically was restricted to polar bears. The most recent insight into this story was released by the National Academies of Science in June 2012 and suggested based up genetics research that hybridization between Polar Bears and Brown Bears (grizzly) has a long history with suggestion of other relationships to historic climate http://www.pnas.org/content/early/2012/07/20/1210506109.abstract (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	Modern hybrids of polar bears and grizzlies have been shot by hunters. However, there are no publications in peer reviewed literature on this issue. Linkage of hybrids to climate change is speculative and unsupported by the literature. The suggested reference Miller et al. (2012) is included in the following addition "Polar bears evolved from a brown bear (U. arctos) ancestor and despite episodic admixture, the genome of polar bears shows ecological adaptations likely associated with the Arctic (Miller et al. 2012). " There is little concrete that can be said beyond this and dealing with the evolutionary history is a temporal context far outside that of modern climate change.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
208	35255	28	13	29	15	6	A well-written section that "nails" the polar bear/climate change situation. This section is clearly written by specialists who know what they are talking about. The literature coverage is extremely good and the integration of material logical and quite excellent. (Ellen Øseth, Norwegian Polar Institute)	No changes requested.
209	43654	28	13	44	14	34	These three paragraphs include much repetition. Please edit to be more fluent. For example page 13 lines 48-49 is somewhat repetition with lines 4-6 on page 14. And on page 14 lines 13-15 are the same information as on lines 27-28 on the same page. (Marjut Kaukolehto, University of Helsinki)	Noted
210	51788	28	13	48	13	51	It would be helpful to specify the relevant time frame for these observations. (Katharine Mach, IPCC WGII TSU)	Inserted "between 1977 and 2010, "
211	40987	28	14	0	0	0	I am not sure where the right place for this concept. It is important to recognize somewhere that most aboriginal peoples in the north did not occupy permanent settlements- they were migratory - often utilizing seasonal encampments that were strategically located to provide access to resources. Few are still migratory- the reindeer herders being the obvious exception. Relocation into permanent settlements was often imposed by government and other institutions for reasons such as education, the establishment of national sovereignty or to meet economic needs of both industry and in some cases the local peoples (Fur trade, mining, whaling industry etc.). As a result localized populations of traditional food sources face heavy harvesting pressures- a situation made worse by the growing size of community populations. Also people must travel to camps to take advantage of resources that are not in close proximity to communities, a challenge considering the participation of many of these people at least seasonally in the wage economy and family commitments such as school etc. The result is people become even more dependent on imported store bought food stuffs. At the same time these people are not as vulnerable to fluctuations in populations and migrations of target wildlife species. (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	Fair comment but dealing with this issue seems more appropriate for sections dealing with humans and social impacts rather than the core biological responses to climate change.
212	51789	28	14	13	14	16	For this projection, the author team may wish to specify the relevant climate/socio-economic scenarios and relevant drivers (potentially also moving this forward-looking statement to 28.3). (Katharine Mach, IPCC WGII TSU)	Movement of text to other sections was not something I could consider. The scenarios examined used 10 GCM and A1B "business as usual" emissions - text included "based on the A1B scenario and sea ice changes".
213	51790	28	14	29	14	30	For this projection, the author team may wish to specify the relevant climate/socio-economic scenarios and relevant drivers (potentially also moving this forward-looking statement to 28.3). (Katharine Mach, IPCC WGII TSU)	Text now includes "due to sea ice loss related to the A1B scenario "
214	51791	28	14	32	14	34	As appropriate, the author team may wish to specify the relevant time frame and climate/socio-economic scenario for the statement. (Katharine Mach, IPCC WGII TSU)	The changes made in the 2 previous comments appear to deal with this issue.
215	37587	28	14	36	0	0	Sentence is unclear. Perhaps inserting "... at times of maximal ice melt." (Jon Rosales, St. Lawrence University)	Done
216	37588	28	14	44	14	45	Sentence starting with, "Later arrival..." is unclear. (Jon Rosales, St. Lawrence University)	Changed to "Later formation and arrival of sea ice in autumn..."
217	51792	28	14	44	14	45	It would be helpful to specify the timeframe relevant here. (Katharine Mach, IPCC WGII TSU)	4 studies are cited so I have inserted "over the last decades" to clarify the time period.
218	36631	28	15	3	15	5	If there is only limited evidence that polar bears can adapt to sea ice decline (ref required), how can there be "high confidence" that the bears will not adapt... (Jeff Ridley, UK Met Office)	text is modified for clarity and 2 references added, 1 new
219	37254	28	15	6	0	0	There is nothing in this section about the potential effects of increased shipping/oil and gas development/fishing on polar bears. Again, I don't know whether there should be, I am just pointing it out. (Erica Head, Fisheries and Oceans Canada)	While increased exploration and development of Arctic resources is an issue, the threats are broad and not species or taxa specific.
220	35256	28	15	8	16	16	A big step down in quality from the polar bear section in terms of quality of the writing and appropriate coverage and interpretation of the literature. This section requires expert advice from a specialist to revise the text, and possibly rewrite it entirely. Some missing references are listed below as an indicator of the lack of coverage of available, relevant literature: Freitas, C., Kovacs, K.M., Ims, R.A. and Lydersen, C. 2008. Predicting habitat use by ringed seals in a warming Arctic. Ecological Modelling 217: 19-32. Gilg, O., Kovacs, K.M., Aars, J., Fort, J., Gauthier, G., Gramillet, D., Ims, R.A., Meltøfte, H., Moreau, J., Post, E., Schmidt, N.M., Yannic, G. and Bollache, L. 2012. Climate change and the ecology and evolution of Arctic vertebrates. Annals of the New York Academy of Science – 1249: 166-1290. Doi.10.1111/j.1749-6632.2011.0641.x Jensen, S.K., Lydersen, C., Kovacs, K.M., Åsbakk, K. and Aars, J. 2010. The prevalence of Toxoplasma gondii in polar bears and its marine mammalian prey; evidence for a marine transmission pathway? Polar Biology 33: 599-606. Kovacs, K.M. and Lydersen, C. 2008. Climate change impacts on seals and whales in the North Atlantic Arctic and adjacent shelf seas. Science Progress 91(1): 117-150. Kovacs, K.M., Aguilar, A., Aurioules, D., Burkanov, V., Campagna, C., Gales, N., Gelatt, T., Goldsworthy, S., Goodman, S.J., Hofmeyr, G.J.G., Härkönen, T., Lowry, L., Lydersen, C., Schipper, J., Sipilä, T., Southwell, C., Stuart, S., Thompson, D. and Trillmich, F. 2012a. Global threats to pinnipeds. Marine Mammal Science 28: 414-436. Kovacs, K.M., Michel, C., Bluhm, B., Gaston, T., Gradinger, R., Hunt, G.L., Moore, S., Renaud, P. and Rysgaard, S. 2012b. Chapter 9.3 - Biological Impacts of Changes to Sea Ice Pp. 32-51 In Arctic Climate Change and the Cryosphere: Snow, Water, Ice, and Permafrost in the Arctic (SWIPA). AMAP, Oslo. Simpkins, M., Kovacs, K.M., Laidre, K. And Lowry, L. 2009. A framework for monitoring arctic marine mammals. CAFF CBMP Report No. 16 Vincent, W.F., Callaghan, T., Dahl-Jensen, D., Johansson, M., Kovacs, K.M., Michel, C., Prowse, T., Reist, J.D. and Sharp, M. 2011. Climate impacts on Arctic ecosystems and ecosystem coupling - Ecology Synthesis SWIPA. AMBIO 40: 87-99. DOI 10.1007/s13280-011-0218-5. (Ellen Øseth, Norwegian Polar Institute)	Freitas et al. included and used in 2 locations. Kovacs and Lydersen 2008. Science Progress - this is a commissioned paper and the peer review process for the journal is unclear but I have included it now as general background. Kovacs et al. 2012b and Simpkins et al. - I have not included. The peer review process on these works is questionable and I have tried to restrict references to peer reviewed papers.
221	51793	28	15	27	15	29	If there are any generalizable connections between the various attributes mentioned and outcomes for species, it may be helpful to expand this statement slightly perhaps with relevant examples. (Katharine Mach, IPCC WGII TSU)	This would require substantial additional text.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
222	42886	28	15	35	15	48	I don't necessarily disagree with the statements made in this paragraph. However, I am concerned as most of this is best guesses as to how the animals will respond and which ones are going to be resilient and which ones will not be. I could come up with alternative species as being more vulnerable than the ones they list. This is an area where research is desperately needed to better understand the habitat requirements of these species (Daniel Costa, University of California Santa Cruz)	Agree but the only sources available are those published in the peer reviewed literature.
223	51794	28	15	38	15	45	As possible, it would be beneficial to clarify the relevant mechanisms, for example indicating why a given species is "most at risk" or "least sensitive." (Katharine Mach, IPCC WGII TSU)	This is a major expansion of the section. Given space constraints it was not attempted. I estimate 1-2 additional pages. The references cover this issue.
224	51795	28	16	1	16	4	For these statements, the author team may wish to clarify the relevant time frames and geographic areas. (Katharine Mach, IPCC WGII TSU)	This is a major expansion of the task requested. I estimate 2+ pages to address this for all species.
225	42887	28	16	1	16	15	There is no mention of walrus in this section. I would argue that they are going to be the most sensitive, as they are benthic feeders and availability of ice as a platform to forage from will be greatly impacted (Daniel Costa, University of California Santa Cruz)	A new reference MacCracken 2012 was inserted. This references was not published at the time of the earlier draft.
226	36632	28	16	9	0	0	Suggested including following about ringed seals: "Ringed seals build subnivean lairs in snow drifts that collect near hummocks of deformed sea ice. In recent years, the survival of seal pups to adult age has been unsuccessful in regions without at least 20 cm of snow on level sea ice in April [e.g., Ferguson et al., 2005]. Based on a 20 cm April snow depth threshold in the multi-model mean of the CMIP5 models, it is estimated the area of suitable habitat for ringed seal reproduction north of 70° N decreases by nearly 70% over the 21st century [Hezel et al., GRL, submitted]." (Jeff Ridley, UK Met Office)	Ferguson et al. 2005 was added along with Harwood et al. 2000 with associated text. I have included Hezel et al. 2012 which is now published in Geophysical Research Letters but was not available for the earlier draft.
227	37257	28	16	16	0	0	There is nothing in this section about the potential effects of increased shipping/oil and gas development/fishing on marine mammals. Since it seems to be important in other regions, I think it should be brought forward here (Erica Head, Fisheries and Oceans Canada)	This is an indirect effect of climate change and while relevant, it would require additional space which is limited. There is little literature on such "additional" or "induced" and all would be rather speculative.
228	45181	28	16	18	0	0	I found this section relatively unbalanced compared to the Arctic section (28.2.2.1) (2.5 pages devoted to Antarctica versus 6.5 pages for the Arctic), and I think it does not reflect the literature. There are many studies of the ecological impacts of climate change in the southern ocean and Antarctica. The Arctic part is comprehensive and well organized, and I suggest using a similar structure for the Antarctica. The Arctic section focuses on some case studies: seabirds, polar bear and marine mammals. For Antarctica, case studies could be: seabirds, krill as a keystone species and marine mammals. There is a significant body of work on penguins that should deserve an entire sub-section, like for polar bears. Adélie penguin in particular, is a very good example of how climate change affects individuals (foraging behaviors, survival, fecundity) and populations across the entire species distribution over decadal and geological timescales. In addition to references already cited see additional major references below (but a more comprehensive literature review will be required): (Stephanie Jenouvrier, Woods Hole Oceanographic Institution)	the section has now been revised to be modelled on the Arctic sections.
229	45182	28	16	18	0	0	Ainley, D. The Adélie penguin: Bellwether of climate change. Columbia University Press, 2002, (Stephanie Jenouvrier, Woods Hole Oceanographic Institution)	this reference has been cited in more recent references. As a result, it is not included here
230	45183	28	16	18	0	0	Ainley, D.; Russell, J.; Jenouvrier, S.; Woehler, E.; Lyver, P.; Fraser, W. & Kooyman, G. Antarctic penguin response to habitat change as Earth's troposphere reaches 2 degrees above preindustrial levels. Ecological Monographs, 2010, 80, 49-66 (Stephanie Jenouvrier, Woods Hole Oceanographic Institution)	noted
231	45184	28	16	18	0	0	Forcada, J. & Trathan, P. N. Penguin responses to climate change in the Southern Ocean. Global Change Biology, 2009, 15, 1618-1630 (Stephanie Jenouvrier, Woods Hole Oceanographic Institution)	noted
232	45185	28	16	18	0	0	Emmerson, L. & Southwell, C. Adélie penguin survival: age structure, temporal variability and environmental influences. Oecologia, 2011 (Stephanie Jenouvrier, Woods Hole Oceanographic Institution)	noted
233	45186	28	16	18	0	0	Emmerson, L. & Southwell, C. Sea ice cover and its influence on Adélie penguin reproductive performance. Ecology, 2008, 89(8), 2096-2102 (Stephanie Jenouvrier, Woods Hole Oceanographic Institution)	noted
234	45187	28	16	18	0	0	Ballerini, T.; Tavecchia, G.; Olmastroni, S.; Pezzo, F. & Focardi, S. Nonlinear effects of winter sea ice on the survival probabilities of Adélie penguins. Oecologia, 2009, 161, 253-265 (Stephanie Jenouvrier, Woods Hole Oceanographic Institution)	noted
235	45188	28	16	18	0	0	Jenouvrier, S.; Barbraud, C. & Weimerskirch, H. Sea ice affects the population dynamics of Adélie penguins in Terre Adélie. Polar Biology, 2005, 29, 413-423 (Stephanie Jenouvrier, Woods Hole Oceanographic Institution)	noted
236	45189	28	16	18	0	0	Dugger, K. M.; Ainley, D. G.; Lyver, P. O.; Barton, K. & Ballard, G. Survival differences and the effect of environmental instability on breeding dispersal in an Adélie penguin meta-population. Proceedings of the National Academy of Sciences, 2010, 107, 12375-12380 (Stephanie Jenouvrier, Woods Hole Oceanographic Institution)	noted
237	45190	28	16	18	0	0	Emslie, S. D.; Coats, L. & Licht, K. A 45,000 yr record of Adélie penguins and climate change in the Ross Sea, Antarctica. Geology, 2007, 35, 61. (Stephanie Jenouvrier, Woods Hole Oceanographic Institution)	noted
238	45191	28	16	18	0	0	Ballard, G.; Dugger, K.; Nur, N. & Ainley, D. Foraging strategies of Adélie penguins: adjusting body condition to cope with environmental variability. Marine Ecology Progress Series, 2010, 405, 287-302 (Stephanie Jenouvrier, Woods Hole Oceanographic Institution)	noted
239	51796	28	16	18	0	0	Section 28.2.2.2. The author team may wish to tighten and focus this section further upon revision. (Katharine Mach, IPCC WGII TSU)	the section has now been revised to be modelled on the Arctic sections.
240	35257	28	16	18	18	30	This sections' writing is under-developed. There are many places in the text that suggest that change is happening, but instead of explaining what kind of change is occurring, there is only a long list of references provided. Examples of this is found at page 17, line 40-47 and at page 18, line 12-17. (Ellen Øseth, Norwegian Polar Institute)	the section has now been revised to be modelled on the Arctic sections.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
241	36674	28	16	20	16	24	If this statement regarding organisms inhabiting polar oceans is also true for the Arctic than why only mention it in the section on the Antarctic. Perhaps this statement should be made in the introduction to section 28.2.2 (Sharon Smith, Geological Survey of Canada)	reference to the Arctic removed here
242	44679	28	16	22	0	42	There are a number of papers of Russian paleogeographers which describe the recent changes in the margins of taiga-tundra, f.e. - 2001 Shiyatov, S., Tcheklov, O. Spatio-temporal dynamics of forest-tundra ecosystems under climate change in the Polar Ural Mountains. Tree-rings and people, Davos, Switzerland; 2) 2000 Hantemirov, R. M. Climate changes and polar timberline dynamics in the northwestern Siberian plain during last 6000 years reconstructed using supra-long tree-ring chronology. International Conference on Dendrochronology for the Third Millennium, Mendoza, Argentina, 2-7 April, 2000 (Maria Ananicheva, Institute of Geography)	Noted. Dedicated author knowing Russian literature could help
243	51797	28	16	30	16	31	For this statement, the author team should consider specifying the timeframe of the observed change. Additionally, the phrase "medium confidence," as calibrated uncertainty language, should be italicized. (Katharine Mach, IPCC WGII TSU)	more accurately represented this work as comparing extant forams with Holocene forams.
244	47136	28	16	31	16	32	Please add: "...but laboratory and field experiments show that krill larval development (Kawaguchi et al., 2011) and post-larval 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)) may be impeded with long-term consequences for Antarctic krill populations. (Vincent Saba, NOAA National Marine Fisheries Service)	point was included
245	37255	28	16	35	0	0	"whereas other herbivores, such as salps and copepods exploit smaller size classes" I am sure that salps and copepods eat large diatoms if they are present, although they probably can eat smaller particles – so – how about "whereas other herbivores, such as salps and copepods can exploit smaller size classes" (Erica Head, Fisheries and Oceans Canada)	included this change
246	51798	28	16	38	16	38	"likely" -- If this term is being used per the uncertainties guidance for authors (reflecting a probabilistic basis for its assignment), it should be italicized. Casual usage of this reserved likelihood term should be avoided. (Katharine Mach, IPCC WGII TSU)	word removed
247	37256	28	16	39	0	0	"lower to upper trophic levels (Holm-Hansen et al. 2004), and possibly as a source of iron for primary producers through a process of whales consuming krill and returning iron to the surface waters in its faeces (Nicol et al. 2010)." I don't think there is any real evidence for nutrient (or iron) regeneration by whales, so I would be even more circumspect on this. Thus: "lower to upper trophic levels (Holm-Hansen et al. 2004). Based on historical data on baleen whale abundance and measurements of iron in their faeces and in krill, Nicol et al. (2010) have suggested that prior to their exploitation, whales might have provided an important source of iron to the surface layers." (Erica Head, Fisheries and Oceans Canada)	adjusted
248	47137	28	16	40	16	40	Please add: "...primary producers through excretion processes (Tovar-Sanchez et al., 2007; Schmidt et al. 2011) and through the process of whales consuming....." (Tovar-Sanchez, A., Duarte, C.M., Hernández-León, S., and S.A. Sañudo-Wilhelmy. 2007. Krill as a central node for iron cycling in the Southern Ocean. Geophys. Res. Lett. 34: L11601, doi:10.1029/2006GL029096) (Schmidt, K., Atkinson, A., Steigenberger, S., Fielding, S., Lindsay, M.C.M., Pond, D.W., Tarling, G.A., Klevjer, T.A., Allen, C.S., Nicol, S., and E.P. Achterberg. 2011. Seabed foraging by Antarctic krill: Implications for stock assessment, benthic-pelagic coupling, and the vertical transfer of iron. Limnol. Oceanogr. 56(4): 1411-1428) (Vincent Saba, NOAA National Marine Fisheries Service)	considered in revision
249	40974	28	16	45	0	0	ACC- assume you mean the Antarctic Circumpolar Current- glossary (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	clarification given
250	43655	28	16	45	0	0	Open the acronym ACC. (Marjut Kaukolehto, University of Helsinki)	clarification given
251	36633	28	16	46	16	47	citations in two groups -combine. (Jeff Ridley, UK Met Office)	ok
252	51799	28	17	2	17	2	"likely" -- If this term is being used per the uncertainties guidance for authors (reflecting a probabilistic basis for its assignment), it should be italicized. Casual usage of this reserved likelihood term should be avoided. (Katharine Mach, IPCC WGII TSU)	word removed
253	40975	28	17	23	0	0	WAP? Western Antarctic Peninsula? (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	defined
254	43656	28	17	23	0	0	Open the acronym WAP. When using the term that you will use an acronym for for the first time, open the acronym. (Marjut Kaukolehto, University of Helsinki)	defined
255	36635	28	17	23	17	23	Use of the abbreviation WAP presumably for Western Antarctic Peninsula has not been previously defined - in any case probably needs redefining in each section. (Jeff Ridley, UK Met Office)	defined
256	49227	28	17	23	17	23	Please define WAP (Oyvind Christophersen, Climate and Pollution Agency)	defined
257	39095	28	17	23	17	27	Changes in diets of Adélie Penguins since the Holocene detailed in various Emslie studies (Polar Biol 25, 222-229; Antarctic Science 17, 57-66) related to changes in oceanography and climate post-Holocene, should be cited. (Eric Woehler, University of Tasmania)	considered
258	37327	28	17	23	18	10	Comment: Add illustrations of population trends for West Antarctic organisms. I suggest the inclusion of some illustrations of relatively long-term trends in penguin colonies. One example is in the paper about West Antarctic colonies by Trivelpiece et al. (2011). The paper documents population changes during the last three decades of Adélie and chinstrap penguins at two study sites in the South Shetland Islands. Trivelpiece's Figure 3.A illustrates that the population change at both sites have been substantial, that at one study site the change was linear, and that it probably was linear at the other study site. Other examples could be illustrated also, because the trends at the West Antarctic study sites contrast sharply with the minor population changes around other parts of the Antarctic coast, and especially with the accelerating rate of change in Arctic organisms that is summarized above in Section 28.2.2.1. (Thomas Dunning Newbury, U.S. Department of the Interior (retired))	noted
259	42888	28	17	26	0	0	add elephant seals to the list of species, should read Gentoo penguins and elephant seals (Daniel Costa, University of California Santa Cruz)	done

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
260	39094	28	17	32	17	35	Bricher et al (2008, Polar Biology 31, 1397-1407) investigated snow accumulation on Adélie Penguin colonies and population trends, should be cited here as methods more sophisticated than Patterson study. It should be mentioned that efforts made to disentangle climate-related changes from human impacts associated with tourism etc. (Eric Woehler, University of Tasmania) Causes are unknown - so why include this as a climate impact?? (Jeff Ridley, UK Met Office)	noted
261	36634	28	17	37	17	38		noted
262	39096	28	17	40	17	44	Woehler et al (2002, Polar Biology 25, 921-927) reports increasing albatross population due to climate amelioration at Heard Island, also Woehler (2006, Status and conservation of the seabirds of Heard Island and the McDonald Islands. In: Green K and Woehler EJ (eds) Heard Island, Southern Ocean Sentinel. Surrey Beatty and Sons, Chipping Norton, pp 128-165) reviews all seabird populations at Heard Island, reports on increasing King Penguin population as glacial recession and climate amelioration occurs there. Also worth citing (reviewed in Chambers et al. 2011 Emu 111:235-251) re climate-related changes in Southern Ocean seabirds. (Eric Woehler, University of Tasmania)	recent reviews of climate impacts on seabirds (Barbraud etal 2012) were used as the basis for the commentary in the region
263	39097	28	17	40	17	44	See also Woehler & Croxall 1997 (Marine Ornithology 25, 43-66) for review of seabird trends in Southern Ocean, more recent review Chambers et al 2011 Emu 111:235-251. (Eric Woehler, University of Tasmania)	recent reviews of climate impacts on seabirds (Barbraud etal 2012) were used as the basis for the commentary in the region
264	39099	28	17	40	17	47	Cite Ainley et al (2010, Ecological Monographs 80, 49-66) detailed analyses re Antarctic penguins and climate changes (Eric Woehler, University of Tasmania)	text revised and example reviews included
265	42889	28	17	40	17	47	Weimerskirch, H., Louzao, M., de Grissac, S. & Delord, K. 2012 Changes in Wind Pattern Alter Albatross Distribution and Life-History Traits. Science 335, 211-214: Changes in foraging patterns of albatrosses have already been documented in response to changing wind patterns (Daniel Costa, University of California Santa Cruz)	text revised and example reviews included
266	51800	28	17	49	17	52	For the response described here, it would be helpful to specify the relevant time frame. (Katharine Mach, IPCC WGII TSU)	noted
267	51802	28	18	1	18	10	For these statements, the author team should specify the relevant time frame. (Katharine Mach, IPCC WGII TSU)	noted
268	37328	28	18	1	18	29	Comment: Add a marine-ecosystem summary with illustrations. The four paragraphs on page 18 are concluding ones for the Marine Ecosystem section in general. Presently, they describe additional data about trends in marine mammal and bird populations in the Indian Ocean sector, penguin colonies on subantarctic islands, and eastern Antarctic humpback whale populations. I think that the Marine Ecosystem section should end with an overall summary. The most important conclusion is not whether some populations are increasing or decreasing, but whether the rates of change are accelerating or not. The Executive Summary explains that an AR5 WGI conclusion is apparently that the rates of some physical "changes . . . may be accelerating" (page 2, line 44). In order maintain a close relationship between the WGI and WGII reports, the WGII report could highlight additional observations that illustrate whether or not some Antarctic temporal rates of ecological change are accelerating. Ecological relationships are often more complicated than physical ones, so temporal trends are not as obvious. Also, some ecological changes, such as increased primary production, might seem "good" to many readers. However, the reason for a clear overall summary of the changes is simply to help determine if the rates of climate-change impacts are decelerating or accelerating. (Thomas Dunning Newbury, U.S. Department of the Interior (retired))	will consider in consultation with other experts involved in the development of the community papers
269	44680	28	18	3	0	0	Also there are not mentioned Russian papers concerning birds& environmental and climate change in Russin Arctic, the authors are M.V. Gavrilov (AARI), G.V. Tertitsky (IGRAS) and many others (Maria Ananicheva, Institute of Geography)	text revised
270	39098	28	18	12	18	17	Woehler et al (2002, Polar Biology 25, 921-927) reports increasing albatross population due to climate amelioration at Heard Island, should be cited here. (Eric Woehler, University of Tasmania)	text revised and recent example reviews included
271	42899	28	18	12	18	17	Weimerskirch, H., Louzao, M., de Grissac, S. & Delord, K. 2012 Changes in Wind Pattern Alter Albatross Distribution and Life-History Traits. Science 335, 211-214 (Daniel Costa, University of California Santa Cruz)	text revised included
272	45192	28	18	19	0	0	For seabirds, there is a good recent review by Barbraud, C.; Rolland, V.; Jenouvrier, S.; Nevoux, M.; Delord, K. & Weimerskirch, H. Effects of climate change and fisheries bycatch on Southern Ocean seabirds: a review. Marine Ecology Progress Series, 2012. (Stephanie Jenouvrier, Woods Hole Oceanographic Institution)	text revised and recent example reviews included
273	42890	28	18	19	18	29	There is very little discussion of the potential impact of climate change on cetaceans. While the problem is little is known, there are still some serious potential problems. Bkue whales are krill specialists and if krill declines, their prey will go. Right whales have been increasing as have humpback whales. However, food chain effects could have negative impacts. Species like humpback whales and minke whales may be better able to respond to cahnges as they have a broader diet then right whales and blue whales. (Daniel Costa, University of California Santa Cruz)	point considered in revised text but difficult in the absence of publications
274	39100	28	18	22	18	27	Cite Ainley et al (2006, Ecology 87, 2080-2093) analyses competition between penguins and cetaceans in the Antarctic and ecosystem functions (Eric Woehler, University of Tasmania)	text revised and recent example reviews included

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
275	36675	28	18	32	0	0	Section 28.2.3 - Shouldn't there be some discussion of the changes in the terrestrial physical environment and its implications for ecosystems? This might include changes in drainage associated with changing permafrost conditions which will impact vegetation. Other examples include landscape instability (slumping etc.) that may have impacts on terrestrial ecosystems (see for example Lantz et al. 2009; Paulter et al. 2010) A recent Canadian report on biodiversity and ecosystems status and trends did a fairly good job at considering the linkages between changes in the physical environment and ecosystems and the authors may want to consider this document and the technical reports on which it is based (see Fed. Prov. & Terr. Govt of Canada 2010). Refs: Paulter BG, Simpson AJ, McNally DJ, Lamoureux SF, Simpson MJ (2010) Arctic permafrost active layer detachments stimulate microbial activity and degradation of soil organic matter. Environmental Science and Technology 44 (11):4076-4082 Lantz TC, Kokelj SV, Gergel SE, Henry GHR (2009) Relative impacts of disturbance and temperature: persistent changes in microenvironment and vegetation in retrogressive thaw slumps. Global Change Biology 15:1664-1675. doi:10.1111/j.1365-2468.2009.0197.x Federal, Provincial & Territorial Governments of Canada (2010) Canadian Biodiversity: Ecosystem Status and Trends 2010. Canadian Councils of Resource Ministers, Ottawa, ON. Available at www.biodivcanada.ca/ecosystems (Sharon Smith, Geological Survey of Canada)	Noted
276	41959	28	18	32	0	0	Section 28.2.3, Comment: Information from numerous publications on permafrost Changes and Vulnerability is almost entirely missing from this section (Vladimir Romanovsky, University of Alaska Fairbanks)	Noted
277	51801	28	18	32	0	0	Section 28.2.3. For the subsections of this section, it would be helpful to clarify consideration of the Antarctic versus the Arctic in the subsection titles. Additionally, for the introductory paragraphs on lines 34-42, the author team should consider introducing Antarctic terrestrial ecosystems as well. Finally, all calibrated uncertainty language used in this section should be italicized (for example, on line 47, page 18; line 10, page 19; lines 5 and 29, page 21; line 17, page 22). (Katharine Mach, IPCC WGII TSU)	Noted
278	45193	28	18	34	0	0	Add a sentence to introduce Antarctica (for example p 24 I3-6) (Stephanie Jenouvrier, Woods Hole Oceanographic Institution)	Made it clear that this section is about the Arctic
279	43657	28	18	34	18	35	This is confusing sentence, please check the place of brackets. Holocene is the last 10000 years. Now you indicate in brackets that "...Holocene (last 120000 years)..." (Marjut Kaukolehto, University of Helsinki)	Disagree, it should be quite clear from the text that it is the period "late Pleistocene" + "Holocene", here restricted to the last 120 000 yrs
280	43658	28	18	42	0	0	AMAP reference is missing from the refs list. (Marjut Kaukolehto, University of Helsinki)	Included now
281	36676	28	18	42	18	42	There has not really been a good summary provided on changes in the arctic cryosphere, particularly the terrestrial cryosphere. There was much work done during the IPY that could be mentioned. For example a recent paper by Derksen et al. (2012) discusses variability and change in the Canadian cryosphere which also discusses some of the implication of these changes. There has also not been much on changing permafrost conditions especially given the relevance to impacts on infrastructure (the Asia ch 24 provides more info for polar region than provided here) Romanovsky et al. (2010a) describe changes in permafrost conditions for the entire Arctic (regional summaries are also provided by Smith et al. 2010, Christiansen et al. 2010, Romanovsky et al 2010b). Refs: Derksen C, Smith SL, Sharp M, Brown L, Howell S, Copland L, Mueller DR, Gauthier Y, Fletcher C, Tivy A, Bernier M, Bourgeois J, Brown R, Burn CR, Duguay C, Kushner P, Langlois A, Lewkowicz AG, Royer A, Walker A (2012) Variability and change in the Canadian cryosphere. Climatic Change. doi:10.1007/s10584-012-0470-0 Romanovsky VE, Smith SL, Christiansen HH (2010a) Permafrost thermal state in the polar Northern Hemisphere during the International Polar Year 2007-2009: a synthesis. Permafrost and Periglacial Processes 21:106-116 Romanovsky VE, Drozdov DS, Oberman NG, Malkova GV, Kholodov AL, Marchenko SS, Moskalenko NG, Sergeev DO, Ukrainsteva DG, Abramov AA, Vasiliev AA (2010) Thermal state of permafrost in Russia. Permafrost and Periglacial Processes 21:106-116 Smith SL, Romanovsky VE, Lewkowicz AG, Burn CR, Allard M, Clow GD, Yoshikawa K, Throop J (2010) Thermal state of permafrost in North America - A contribution to the International Polar Year. Permafrost and Periglacial Processes 21:117-135 Christiansen HH, Etzelmuller B, Isaken K, Juliussen H, Farbot H, Humlum O, Johansson M, Ingeman-Neilsen T, Kristensen L, Hjort J, Holmlund P, Sannel ABK, Sigsgaard C, Akerman J, Foged N, Blikra LH, Pernosky MA, Odegard R (2010) Thermal state of permafrost in the Nordic area during the IPY 2007-2009. Permafrost and Periglacial Processes 21:156-181 (Sharon Smith, Geological Survey of Canada)	Ch 4 of WG II + WG 1 (cryosphere chapter) cover permafrost
282	36677	28	18	42	18	42	Does AMAP 2011 refer to the SWIPA document? Need to be consistent regarding references to this document. (Sharon Smith, Geological Survey of Canada)	AMAP 2011 is SWIPA
283	40976	28	19	1	19	5	Figure 28-2 The table - part b needs additional explanation either as a legend or as text. What is red versus blue days and decades? How is a minus 20 an advancement unless it means 20 days earlier? (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	Blue and red dots are statistically significant and not significant changes respectively, and this is explained in the figure text. The figure text is copied from the publication
284	36636	28	19	8	0	0	Style: Leading with a confidence on change has not been the style for previous sections (Jeff Ridley, UK Met Office)	The wording has been changed in accordance with the guidelines
285	48005	28	19	8	20	51	I would suggest that this chapter and specifically this section might benefit if it included a more substantial discussion of the potential for terrestrial vegetation changes through incursion of insects (not just as disease vectors, but as borers and consumers of plant material) (Patricia Jacobberger-Jellison, NASA)	The main impact of insects as defoliators is not in the tundra zone but in the deciduous and coniferous forest zone. for example, Epirrita autumnata defoliates large areas of mountain birch forest in northern Fennoscandia. this is discussed on p. 21 starting from line 40.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
286	48956	28	19	10	0	16	It is not clear why reindeer trampling and oil development increase the graminoid vegetation in the Arctic. (Svein Disch Mathiesen , International Centre for Reindeer Husbandry)	There are dozens of publications on the relationship between reindeer trampling and oil development and increased graminoid cover going back several decades and from all sectors of the arctic. This is described and discussed as factors affecting tundra vegetation in the publications referred to and hence we have to mentioned it
287	51803	28	19	12	19	12	"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. Casual usage of this reserved likelihood term should be avoided. (Katharine Mach, IPCC WGII TSU)	OK,it is changed
288	36678	28	19	18	19	18	Need to properly define NDVI. Isn't NDVI simplify a spectral ratio (or classification) which can be utilized to infer something about condition of vegetation and productivity? NDVI isn't defined as plant productivity. (Sharon Smith, Geological Survey of Canada)	NDVI is a proxy for the leafiness of vegetation in that it is a measure of the spectral components of solar radiation that are absorbed in photosynthesis. The leafiness of vegetation is related to biomass and changes over time give a proxy of productivity. As such, NDVI is indeed not "plant productivity" per se, but it is used widely as an indicator of plant productivity in tundra ecosystems where ground-level studies with hand-held sensors (e.g. Riedel et al. 2005) have repeatedly verified the levels of productivity indicated by the satellite-based index. The text has been changed and clarified on this point
289	40977	28	19	22	0	0	Beringia- is the suggestion over all of Beringia including eastern Siberia northern Alaska and Yukon or only Asian component? My reading of the figure doesn't demonstrate this statement- The only reduction is in south western Alaska and the easternmost region of Russia. The text describes these areas differently in lines 35-36. Beringia is a much larger region. http://ygsftp.gov.yk.ca/publications/posters/Bond_Beringia.pdf (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	Has been clarified and changed
290	36637	28	19	29	19	29	SWI is not used again in the chapter so no need to announce the abbreviation here. (Jeff Ridley, UK Met Office)	OK, SWI is deleted
291	48957	28	19	33	0	47	How much do the seas ice melting influence the NDVI on Yamal (Svein Disch Mathiesen , International Centre for Reindeer Husbandry)	The latest evidence (Macias-Fauria et al. 2012) indicates that the sea ice retreat in the Kara Sea has not had much influence on Yamal NDVI relative to the increasing duration and frequency of high-pressure systems over West Siberia.
292	36638	28	19	33	19	34	Unnecessary redefinition of summer warmth index from that at lines 28-29 (Jeff Ridley, UK Met Office)	No, the first one is the figure text, this is the main text. We must define it in both places
293	51804	28	19	33	19	36	In the chapter text, in addition to in the figure caption, it would be helpful to specify the relevant time frame (1982-2010). (Katharine Mach, IPCC WGII TSU)	OK, done
294	36639	28	19	45	19	47	"Synoptic-scale air masses" is insufficient description - do these represent wet / warm air masses? less cloudy? (Jeff Ridley, UK Met Office)	Has been changed
295	51805	28	19	49	19	51	The chapter team should consider specifying the relevant time frame for this statement as well as for the statement on lines 53-54. (Katharine Mach, IPCC WGII TSU)	OK, done
296	36679	28	19	49	20	11	Lantz et al. (2010) may also be relevant to this discussion. Lantz TC, Gergel SE, Kokelj SV (2010) Spatial heterogeneity in the shrub Tundra Ecotone in the Mackenzie Delta Region, Northwest Territories: Implications for Arctic environmental change. Ecosystems 13:194-204 (Sharon Smith, Geological Survey of Canada)	We do not consider this ref as relevant as others and have left it out due to space limitations
297	36640	28	19	51	19	51	Check consistency of reference to previous IPCC reports; here AR4 but on 18:39 FAR is used (Jeff Ridley, UK Met Office)	OK
298	51806	28	20	4	20	23	The author team should consider specifying relevant time frames for many of these statements. (Katharine Mach, IPCC WGII TSU)	OK, changed
299	36641	28	20	14	20	15	Unnecessary use of double bracket (Jeff Ridley, UK Met Office)	deleted
300	36642	28	20	38	0	0	A paragraph which follows on from that on moss and tundra is needed as regards the effects of fire and the likelihood of increased fire resulting from prolonged droughts in future climate. Fire removes the moss cover and allows other plant types to flourish, but also changes the heat fluxes and annual cycle of soil temperature. Examples of such research are Rupp et al. (2000) Global Change Biology, 6, 541-555.; Rocha & Shaver (2011) Global Change Biology, 17, 2831-2841. ; Yi et al (2009) JOURNAL OF GEOPHYSICAL RESEARCH-BIOGEOSCIENCES, 114, G02015. (Jeff Ridley, UK Met Office)	Cross-refer to ch 4 of WG II which covers forest fire
301	36643	28	20	38	0	0	Section on vegetation blights, such as pine beetle, is missing. This leads to fuel for fires and subsequent soil loss. Soil loss can lead to permanent local biosphere changes. (Jeff Ridley, UK Met Office)	Added two new sentences to cover the topic. The topic is also covered elsewhere in the text for example

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
302	36680	28	21	1	0	0	section 28.2.3.3 - There is not much discussion regarding the impact that changing vegetation conditions may have on snow cover which then effects the ground temperature. As shrubs colonize tundra, vegetation catches snow. See for example Burn and Kokelj (2009), Palmer et al. (2012), Morse et al. (2012) as they may be relevant. Refs: Burn CR, Kokelj SV (2009) The environment and permafrost of the Mackenzie Delta area. Permafrost and Periglacial Processes 20 (2):83-105 Morse PD, Burn CR, Kokelj SV (2012) Influence of snow on near-surface ground temperatures in upland and alluvial environments of the outer Mackenzie Delta, Northwest Territories. Canadian Journal Earth Sciences 49:895-913. doi:10.1139/E2012-012 Palmer MJ, Burn CR, Kokelj SV (2012) Factors influencing permafrost temperatures across tree line in the uplands east of the Mackenzie Delta, 2004–2010. Canadian Journal of Earth Sciences 49:877-894. doi:10.1139/E2012-002 (Sharon Smith, Geological Survey of Canada)	We are aware of this, but have chosen not to cover the topic due to space limitations. The topic is well covered in the SWIPA report from 2011.
303	40978	28	21	1	22	6	See earlier comments re Chapter 28 page 3. You might also want to look at the most recent 2011 Forest Health Report- pages 11-18 re the movement of the Mountain Pine Beetle north (not the spruce bark beetle that was already in the north). http://www.emr.gov.yk.ca/forestry/foresthealth.html Lodgepole Pine is a common species in the Yukon and NWT with large even aged stands often established following fire events. This comment is also important for Chapter 26 (26/14/5)where part of the range reported as Mountain Pine Beetle is actually Spruce Bark Beetle - same genus- different species (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	We have expanded the text on beetles in the vegetaion section and beetles are also dealt with in the fauna section
304	52651	28	21	1	22	6	In Norway upslope expansion of the tree line until now is more attributed to change in land use (decreased grazing by domestic animals such as sheep) rather than climate change (Else Marie Løbersii, Norwegian directorate for nature management)	That grazing is also affecting treeline is elsewhere in the text.
305	43659	28	21	9	21	14	Suggest to add a summarising illustration, a histogram, to clarify the type of treeline responses and their frequency. You could plot on Y axis number of studies or locations and on X axis a bar for 'no change', 'advancement' and 'retreat'. If possible, also a plot showing the locations or study regions. (Marjut Kaukolehto, University of Helsinki)	Due to space limitations we could not do as suggested
306	51807	28	21	22	21	24	For this statement, as appropriate it would be helpful to specify the relevant climate/socio-economic scenario. Additionally, it would be preferable to provide the citations referred to parenthetically on line 22. (Katharine Mach, IPCC WGII TSU)	We did not follow the advise because of space limitations
307	43660	28	21	22	21	27	In the context of treeline advancement it would be important to shortly mention what can be the obstacles of the advancement, since some models can be so unrealistic. The soil may not be developed enough for the advancing ecotype in such a short time, survival of the seedlings, life cycle..? (e.g. Holtmeier F-K & Broll G 2007. Treeline advance - driving processes and adverse factors. Landscape online 1, 1-33. DOI: 10.3097/LO.200701) (Marjut Kaukolehto, University of Helsinki)	Added a new sentence and used the recommended reference
308	44681	28	21	36	0	0	anecdotaly - better to replace by more often used synonym (Maria Ananicheva, Institute of Geography)	This is a mistake. She is referring to another versin of the ms
309	44682	28	21	37	0	0	including (wrong spelling) (Maria Ananicheva, Institute of Geography)	This is a mistake. She is referring to another versin of the ms
310	44683	28	21	38	0	0	I guess OF previously permanent snow cover (not OR) (Maria Ananicheva, Institute of Geography)	This is a mistake. She is referring to another versin of the ms
311	51808	28	21	48	21	48	"likely" -- If this term is being used per the uncertainties guidance for authors (reflecting a probabilistic basis for its assignment), it should be italicized. Casual usage of this reserved likelihood term should be avoided. (Katharine Mach, IPCC WGII TSU)	This is not uncertainty language
312	36681	28	22	3	22	6	Fire may accompany drier conditions but there is no discussion of this. (Sharon Smith, Geological Survey of Canada)	Forest fire will be considered, probably by cross-referring to ch 4 in WGII
313	43661	28	22	4	0	0	for the "browning of the boreal forests you could crossrefer to report chapter 4.3.3.1.1. (Marjut Kaukolehto, University of Helsinki)	OK, done
314	40979	28	22	9	0	0	Two authors worth following up on are David Hik (University of Alberta) and David Mossop (Yukon College). Hik and students have conducted long term studies of Collared Lemming. One recent observations has been related to impacts on the population as a result of warm winter weather events resulting in less snow depth and increased icing (similar to the Abisko data). Mossop has maintained a long term data set dealing with the relationship between Willow Ptarmigan and Gyrfalcons http://www.yukoncollege.yk.ca/research/post/ptarmigan/ a relationship that appears to have been disrupted. (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	These authors are included in oview papers like Elmendorf et al 2012a,b and Callaghan et al 2011 and several othe papers they have co-authored
315	51809	28	22	17	22	23	The chapter team may wish to clarify if the attribution described on line 17 reflects a formal attribution, especially given the description on lines 22-23. (Katharine Mach, IPCC WGII TSU)	This is a formal attribution and it has been changed
316	51810	28	22	31	22	34	It would be helpful to indicate the relevant timeframe for these changes. (Katharine Mach, IPCC WGII TSU)	OK, done
317	51811	28	22	39	22	39	"likely" -- If this term is being used per the uncertainties guidance for authors (reflecting a probabilistic basis for its assignment), it should be italicized. Casual usage of this reserved likelihood term should be avoided. (Katharine Mach, IPCC WGII TSU)	OK, it has been italicized
318	40980	28	22	44	23	37	Should check with Don Russell who chaired the Circum Arctic Rangifer Monitoring and Assessment and who contributed several of the pieces to both the Circumpolar Biodiversity Monitoring Program and the State of the Arctic chapters on caribou. www.carmanetwork.com/ (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	Done and comments included or taken into consideration
319	48958	28	22	46	0	54	Several article published on the High Arctic Svalbard reindeer from differebt authors contradict this text (Svein Disch Mathiesen , International Centre for Reindeer Husbandry)	That is correct and has been pointed to in the text. All relevant publications from Svalbard +are included
320	51812	28	23	5	23	8	It would be helpful to clarify the timeframe for this observation. (Katharine Mach, IPCC WGII TSU)	it is not relevant here
321	51813	28	23	18	23	21	The author team should clarify the time frame for the statements as appropriate. (Katharine Mach, IPCC WGII TSU)	OK, done
322	48959	28	23	26	0	37	Please include: Andersen O 2011 Reindeer herding cultures in northern Quaternary International 238 63-75 (Svein Disch Mathiesen , International Centre for Reindeer Husbandry)	This section is about wild reindeer. Reindeer husbandry is dealt with later. This publication is not about reindeer and climate change and is probably of little relevance for our chapter
323	43662	28	23	36	0	0	hydrocarbon development..' this is ambiguous expression, perhaps use rather 'hydrocarbon extraction development' or 'gas and oil activities/extraction development' to be more clear? (Marjut Kaukolehto, University of Helsinki)	No,hydrocarbon development should be clear and is well defined

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
324	49228	28	23	43	23	43	The extreme weather impact could be backed up with a reference to the SREX, here or one of the other places extreme weather is mentioned as a threat to polar regions (e.g. page 27, line 39, page 30, line 37) (Oyvind Christophersen, Climate and Pollution Agency)	OK, it been done
325	52652	28	23	44	23	52	This section should be expanded (Else Marie Løbersli, Norwegian directorate for nature management)	Sorry, but we have limited space and had to shorten FOD by 50%
326	45194	28	24	3	24	6	Move to p18 I34 (Stephanie Jenouvrier, Woods Hole Oceanographic Institution)	Sections 28.2.3.7-10 have been reduced to one section with the intention of retaining focus on the observed impacts of climate change. These sentences are important for establishing what information is available and have been retained in this section
327	51814	28	24	4	24	8	The author team may wish to clarify the timeframe for these observations. Additionally, for the "anecdotal" reports referenced on line 10, is it possible to provide any citations that mention them? (Katharine Mach, IPCC WGII TSU)	clarified
328	37258	28	24	32	0	0	"Changes in sea-ice and ocean's warming Antarctic Peninsula" Is it appropriate to have this section here? It does not seem to be talking about the terrestrial ecosystem. (Erica Head, Fisheries and Oceans Canada)	covered as appropriate in the marine section
329	45195	28	24	32	0	0	Should be in section 28.2.2.2 p16 (Stephanie Jenouvrier, Woods Hole Oceanographic Institution)	covered as appropriate in the marine section
330	40981	28	24	34	0	0	85 day change over what period of time- a decade, 5 decades what? (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	covered as appropriate in the marine section
331	43663	28	24	35	0	0	before the list could also cross refer to 28.2.2.2.? (Marjut Kaukolehto, University of Helsinki)	covered as appropriate in the marine section
332	51815	28	24	35	24	42	The chapter team may wish to clarify if all of these effects have been observed to date (and if so, over what time frame). (Katharine Mach, IPCC WGII TSU)	covered as appropriate in the marine section
333	42891	28	24	40	24	42	Ant fur seal range is extending further down the WAP. See Costa et al 2010, but the original reference is Siniff, D. B., Garrott, R. A., Rotella, J. J., Fraser, W. R. & Ainley, D. G. 2008 Opinion Projecting the effects of environmental change on Antarctic seals. Antarctic Science 20, 425-435. (Daniel Costa, University of California Santa Cruz)	covered as appropriate in the marine section
334	36682	28	24	45	0	0	Section 28.2.3.8 - Why is there not a similar discussion for the Arctic especially since there is a much greater direct impacts of human activity in the Arctic. For example there are settlements, roads, major natural resource development projects (e.g. mines, oil and gas production and pipelines). There are impacts on terrestrial, coastal and marine environments related to these activities. The impacts of these activities will be in addition to those resulting from climate change in the Arctic. (Sharon Smith, Geological Survey of Canada)	The text on the Arctic deals with human impact.
335	45196	28	24	45	0	0	This should be a separate section (Stephanie Jenouvrier, Woods Hole Oceanographic Institution)	Sections 28.2.3.7-10 have been reduced to one section with the intention of retaining focus on the observed impacts of climate change but noting the other confounding factors that make it difficult to distinguish climate change impacts from other effects that are known to be occurring.
336	39101	28	24	47	25	5	Ruoppolo et al (2012, Wildlife and oil in the Antarctic: a recipe for cold disaster. Polar Record. doi:10.1017/S0032247411000763) review impacts to Antarctic and Subantarctic marine, inter-tidal and terrestrial systems from oil spills, see also Tin et al 2009, Antarctic Science 21, 3-33) for extensive review of all human impacts in Antarctica, see also Woehler et al (accepted) Human Impacts to Antarctic Wildlife: Predictions and Speculations for 2060. In Tin T, Liggett D, Maher P and Lamers M (eds) The future of Antarctica [prov book title] Springer, for most recent review of human impacts and predictions for future. ms can be provided to lead authors on request. See also Ainley, D.G. & Brooks, C. (2012). Exploiting the Southern Ocean: Rational use or tragedy of the commons? In Liggett, D., Hemmings, A.D. & Steel, G. (Eds.) Exploring Antarctic Values. Christchurch, New Zealand: University of Canterbury, Gateway Antarctica Special Publication Series for additional discussions re Southern Ocean fisheries. (Eric Woehler, University of Tasmania)	Sections 28.2.3.7-10 have been reduced to one section with the intention of retaining focus on the observed impacts of climate change but noting the other confounding factors that make it difficult to distinguish climate change impacts from other effects that are known to be occurring.
337	40982	28	24	54	0	0	tourism activities (marine and terrestrial) and shipping (marine) (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	Sections 28.2.3.7-10 have been reduced to one section with the intention of retaining focus on the observed impacts of climate change but noting the other confounding factors that make it difficult to distinguish climate change impacts from other effects that are known to be occurring.
338	51816	28	25	18	25	18	It would be clearest to indicate when this discovery occurred. (Katharine Mach, IPCC WGII TSU)	Sections 28.2.3.7-10 have been reduced to one section with the intention of retaining focus on the observed impacts of climate change but noting the other confounding factors that make it difficult to distinguish climate change impacts from other effects that are known to be occurring.
339	44684	28	25	25	0	40	I think here the fact that frequent change of atmospheric types causes more cases of such diseases as Artery (Benign)hypertension, Hypertension stroke, Stenocardia, Myocardial attack, Cerebral stroke is missed. (Maria Ananicheva, Institute of Geography)	wording revised to reflect the relative importance of human versus natural introductions
340	37297	28	25	25	25	25	This reference should be Cook et al., 2010. Reference: Cook, A. J., Poncet, S., Cooper, A. P. R., Herbert, D. J. and Christie, D. (2010) Glacier retreat on South Georgia and implications for the spread of rats. Antarctic Science, 22 (3): 255-263. (Alison Cook, Swansea University)	changed reference to the correct one

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
341	51817	28	25	41	25	44	"likely" -- If this term is being used per the uncertainties guidance for authors (reflecting a probabilistic basis for its assignment), it should be italicized. Casual usage of this reserved likelihood term should be avoided. (Katharine Mach, IPCC WGII TSU)	wording revised to reflect the relative importance of human versus natural introductions
342	51818	28	26	28	0	0	Section 28.2.4. In the section title, the chapter team might consider indicating the focus of the section on indigenous and isolated populations, as described on page 27, lines 12-14. (Katharine Mach, IPCC WGII TSU)	Noted. Not changed, since section also addresses health and wellbeing for the overall Arctic population.
343	48960	28	26	28	0	28	please change Human populations to human societies. (Svein Disch Mathiesen , International Centre for Reindeer Husbandry)	Both terms would be correct but best to keep title "Human Populations" because it was used in AR4 – for consistency
344	40986	28	26	28	30	40	No where in this section are the challenges of abandoned and orphaned industrial sites and associated contaminants other than those containing nuclear materials get discussed. These materials are often being mobilized as a result of slumping, ground water or thawing permafrost. Invasion of containment structures by tree roots can and have disrupted the integrity of structures. Thawing of the permafrost that has been used to store the arsenic trioxide in the Giant mine in Yellowknife is a classic example. Once mobilized this will cause severe health risks. (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	Acknowledged. Not included due to strict space limitations.
345	45197	28	26	29	0	0	Specify for the general reader that there is no human settlement in Antarctica. (Stephanie Jenouvrier, Woods Hole Oceanographic Institution)	Now, this is stated in the very first sentence of Human Populations section. 28.2.4
346	49229	28	26	31	26	31	replace "environment" with "environmental" (Oyvind Christophersen, Climate and Pollution Agency)	Replaced environment with environmental
347	40983	28	26	37	0	0	scientists, military and tourists (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	Added scientists, military, tourists
348	40984	28	27	12	27	14	Does it also look at the challenges for other human populations which by the statistics on page 26 lines 44-50 are now generally the majority. Other sections of WG II certainly refers to all sectors of the population? I am in agreement with the text that follows however I think one needs to also deal with the rest of the northern population. In many ways the challenges have similarities with isolated communities or cities elsewhere but the northern climate, landscape, isolation and distances add unique challenges. Increasingly, at least a portion of the aboriginal population are participating in a " western economy" at least part time- a point made on page 30 lines 26-30. Other sections of WG II certainly refers to all sectors of the population? I agree there is a need to talk about the specific challenges of the aboriginal population (and for that matter others) who are dependent partially or largely on a traditional lifestyle but even aboriginal groups in Canada also look at their broader needs in terms of where society is trending.. Later on page 27 lines 29- 34 there seems to be a recognition of the need to deal with all but in the second sentence suggests a shortage of research- probably not true but a lack of research that is within the general domain of climate change vulnerabilities. Recent work developing community adaptation strategies (examples the CARMA studies and other studies by the City of Whitehorse, Dawson, Atlin, Mayo etc and most communities in Nunavut go beyond just the aboriginal and traditional life style issues. http://taiga.net/nce/adaptation/projects.html provides access to some examples (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	Added some words toward this concern in SODand will try to improve content for final draft with newly-released literature
349	51819	28	27	13	27	13	"likely" -- If this term is being used per the uncertainties guidance for authors (reflecting a probabilistic basis for its assignment), it should be italicized. Casual usage of this reserved likelihood term should be avoided. (Katharine Mach, IPCC WGII TSU)	"likely" was replaced with "expected"
350	47996	28	27	17	27	34	It is great to see a human health and well-being section in the Polar Regions chapter. I think that this section also needs to mention the mental health challenges that many communities in the North experience to a greater extent than non-polar residents, especially when talking about the complicated factors such as social, cultural, political, and economic forces (line 25). (Ashlee Cunsolo Willox, McGill University)	Mental health issues have been strengthened by additional text in several places in section, "Indirect impacts of climate change on the health of Arctic residents" (28.2.4.1.2), and (2) the entire final paragraph of the section is devoted to mental health. Also, there are several references to mental or neurological impacts from different climate-related situations throughout the section,
351	44685	28	27	24	0	0	"are being compromised by a warming again reducing food available to the community" -requires editing (Maria Ananicheva, Institute of Geography)	Could not find this sentence. Commenter was using a different version so pages don't match
352	43664	28	27	26	0	0	AMAP/UNEP missing from the reference list (Marjut Kaukolehto, University of Helsinki)	Reference added
353	36683	28	27	37	27	37	Do you mean impacts of a changing climate on the health of Arctic residents. (Sharon Smith, Geological Survey of Canada)	Inserted "changing" in front of climate
354	47997	28	27	37	28	14	Arguably, another direct impact (and related to the indirect impacts mentioned after this section below -- climate change is impacting mental health both directly and indirectly) that has been indicated is the negative impacts of climate change and the resulting change in environment, culture, livelihoods, and lifestyle, on mental health and well-being that has been demonstrated by a team in the Canadian North: Cunsolo Willox A, Harper SL, Ford JD, Landman K, Houle K, Edge VL, Rigolet Inuit Community Government: 'From this place and of this place': Climate change, sense of place, and health in Nunatsiavut, Canada. Social Science and Medicine Doi: 10.1016/j.socscimed.2011.03.043; Cunsolo Willox, A., Harper, S., Edge, V., Landman, K., Houle, K., Ford, J., & the Rigolet Inuit Community Government. (2011). 'The land enriches the soul': On environmental change, affect, and emotional health and well-being in Nunatsiavut, Canada. Emotion, Space, and Society. Doi: 10.1016/j.emospa.2011.08.005 (Ashlee Cunsolo Willox, McGill University)	Same as #350 (strengthened mental health coverage)
355	37589	28	27	39	27	42	This sentence could include rapidly changing weather conditions and increasingly unsafe hunting conditions as risks to health (Jon Rosales, St. Lawrence University)	Added these into text

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
356	36684	28	27	42	27	44	A reference to the IPCC Special report (Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation, pub 2012) may be appropriate. Reference to other publications that deal directly with potential changes in these events would be appropriate, eg. Kokelj et al. 2009; Lantz and Kokelj 2008, SWIPA permafrost chapter. Note that fire can also result in increased slope failures (Lipovsky et al. 2006.). Refs: Lipovsky PS, Coates J, Lewkowicz AG, Trochim E (2006) Active-layer detachments following the summer 2004 forest fires near Dawson City, Yukon. In: Emond DS, Bradshaw GD, Lewis LL, Weston LH (eds) Yukon Exploration and Geology 2005. Yukon Geological Survey, pp 175-194 Kokelj SV, Lantz TC, Kanigan J, Smith SL, Coutts R (2009) Origin and polycyclic behaviour of tundra thaw slumps, Mackenzie Delta region, Northwest Territories, Canada. Permafrost and Periglacial Processes 20 (2):173-184. doi:10.1002/ppp.642 Lantz TC, Kokelj SV (2008) Increasing rates of retrogressive thaw slump activity in the Mackenzie Delta region, N.W.T., Canada. Geophysical Research Letters 35 (L06502):5. doi:10.1029/2007GL032433 (Sharon Smith, Geological Survey of Canada)	Added reference to Special Report on Extremes – TSU has advised us to eliminate many references, so did not add the additional references suggested by reviewer
357	51820	28	27	42	27	47	For these statements, the author team may wish to reference the findings of the special report on the extremes and the working group 1 contribution to the 5th assessment report. (Katharine Mach, IPCC WGII TSU)	Added reference to Special Report on Extremes
358	44686	28	27	44	0	0	Interesting work on human health in Russian Arctic should be somehow analyzed. It is a contribution of Russian researchers to the IPY - http://ijch.fi/CHS/CHS_2007%281%29.pdf 'Indigenous Peoples of Northern Russia: Anthropology and Health', Andrew Kozlov, Galina Vershubsky, Maria Kozlova; Circumpolar Health Supplements, 2007, no. 1 (Maria Ananicheva, Institute of Geography)	Valuable reference – used in report
359	40985	28	27	46	0	0	extreme weather events also add challenges for communities to access supplies from the outside. A couple of examples- much of Nunavut is supplied with part of its store bought diet by air transport- the rest by the annual sea lift. In June heavy rainfall events shut down almost all road access to all but the southeast Yukon cutting off fuel and food supplies. Stores were emptied. An airlift was mobilized to supply not just communities such as Whitehorse and Dawson but also tourists and large camps (example exploration camps). This is obviously a similar challenge as communities elsewhere in the world exposed to extreme weather events or other natural (or manmade) disruption. Interestingly this time in the Yukon the tele-communications were not disrupted as the fibre optic cables were preserved by quick acting technicians- the infrastructure which is usually the first to fail. When it does fail it curtails most modern electronic commerce- this did happen to Inuvik this spring for several days and later in Whitehorse resulting in closing of retail outlets because they are dependent on telecommunications to major centres wheremost of the servers that maintain all inventory control are based(vulnerability triggered by globalization of supply chains even in the arctic) (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	Replaced “risks to rural and isolated communities” with “loss of access to critical supplies and services to rural and isolated communities (e.g., food, fuel, telecommunications)”
360	36685	28	27	50	27	52	See also Derksen et al. (2012) for summaries of studies in Canada related to lake and river ice conditions and impact on travel conditions (also includes discussion of tools that can be utilized by communities - adaptation solutions). See also Gautier et al 2010 and Tremblay et al 2008. Refs: Derksen C, Smith SL, Sharp M, Brown L, Howell S, Copland L, Mueller DR, Gauthier Y, Fletcher C, Tivy A, Bernier M, Bourgeois J, Brown R, Burn CR, Duguay C, Kushner P, Langlois A, Lewkowicz AG, Royer A, Walker A (2012) Variability and change in the Canadian cryosphere. Climatic Change. doi:10.1007/s10584-012-0470-0 Tremblay M, Furgal C, Larrivee C, Annanack T, Tookalook P et al (2008) Climate Change in Northern Quebec: Adaptation Strategies from Community-Based Research. Arctic, Supplement: 1–124: Arctic Change and Coastal Communities 61 (5): ISSN 1923-1245; Gauthier Y, Tremblay M, Bernier M, Furgal C (2010) Adaptation of a Radar-Based River ice Mapping Technology to the Nunavik Context. Can J Remote Sens 36(S1):168-185 (Sharon Smith, Geological Survey of Canada)	1. Added Derksen et al, 2012 end of sentence l. 50
361	37612	28	28	24	28	26	Ignatowski and Rosales. 2012. The Local and Professional Science of Climate Change in Two Subsistence Alaskan Villages. Submitted. Could be added to this list of references supporting the sentence ending "...unusual environmental conditions." (Jon Rosales, St. Lawrence University)	Added Ignatowski and Rosales (2012) to end of sentence p. 28, l. 24-26
362	51821	28	29	7	29	7	"likely" -- If this term is being used per the uncertainties guidance for authors (reflecting a probabilistic basis for its assignment), it should be italicized. Casual usage of this reserved likelihood term should be avoided. (Katharine Mach, IPCC WGII TSU)	Replaced “likely” with “expected”
363	44687	28	29	30	0	0	This reference could be useful http://books.google.ru/books?id=8BYVStb-zVAC&pg=PA183&lpg=PA183&dq=Olga+Murashko+north&source=bl&ots=InvNwIFUJH_&sig=oaDb8kC0Vsarvwq2Ed0FUusAXJk&hl=r&u&ei=x9NrTsqCPYKfOs2GjL4F&sa=X&oi=book_result&ct=result&resnum=6&sqi=2&ved=0CEQQ6AEwBQ#v=onepage&q=Olga%20Murashko%20north&f=false (Maria Ananicheva, Institute of Geography)	Commenter was using different version – cannot locate where her comment applies. Also, could not get access to the website
364	37590	28	29	33	0	0	The statement, "and increasingly wet conditions make it harder to dry food for storage" (Jon Rosales, St. Lawrence University)	Added “and increasingly wet conditions make it harder to dry food for storage” before the reference
365	51822	28	29	33	29	34	The author team may wish to also comment on the role of globalization more generally. (Katharine Mach, IPCC WGII TSU)	Added “plus general globalization pressures” after “foods” on line 33
366	37591	28	29	36	29	38	This sentence does not seem correct. All foods are exposed to bioaccumulate environmental contaminants. Foods higher on the food chain biomagnify contaminants. This sentence should be clarified. (Jon Rosales, St. Lawrence University)	Disagree. It is well-documented that contaminants are biomagnified up the food chain in many subsistence animals (e.g., marine mammals)
367	37592	28	29	40	0	0	This source could be added to this sentence: U.S. General Accounting Office's report: Alaska Native Villages Limited Progress Has Been Made on Relocating Villages Threatened by Flooding and Erosion GAO-09-551, Jun 3, 2009. Available at: http://www.gao.gov/products/GAO-09-551 (Jon Rosales, St. Lawrence University)	Added (GAO, 2009). Also added to reference list [p. 29, l. 43]
368	41966	28	29	40	29	52	Landfill sites affected by thawing permafrost and changes in hydrology (Vladimir Romanovsky, University of Alaska Fairbanks)	Added the following: “damage to landfill sites” after “reservoirs” [p. 29, l 43]; and added “changes in hydrology” after “drought” [p.29, l. 45] delete “and” [p. 29, l. 45]

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
369	36686	28	29	43	29	44	Some clarification is required regarding salt-water intrusion and impact on water sources. Does this refer to groundwater resources in these areas? If this is the case, you need to be specific about where this is an issue as groundwater is not utilized throughout significant portions of the Arctic (such as northern Canada). If you are talking about impact on surface water supplies then indicate that is the case. (Sharon Smith, Geological Survey of Canada)	Replaced “sources” with “supplies”
370	36687	28	29	48	29	48	You need to be careful with reference to potential problems in communities that have no in-house piped water source. Several communities in northern Canada utilize trucking for sewage and water supply to avoid issues with frozen ground. The water that is trucked to homes is treated and comes from a community water plant. The issues mentioned in this paragraph are not an issue in these communities. Perhaps it is correct to say that these issues are associated with communities that have no central water supply and treatment source. (Sharon Smith, Geological Survey of Canada)	Added “ in communities with no central water supply or treatment sources,” after “infrastructure” and replace “most seriously” with “This is most serious” [p. 29, l 40]
371	47998	28	30	1	30	11	Again, not to belabour the point, but another extremely important area of study that is emerging in the health field in the North is climate change and mental health. This has been indicated as a priority by communities and researchers alike, and a discussion of the complexities involved in climate change and mental health should be included in order to truly show the range and depth of impacts of climate change on health in the Northern Polar Region. (Ashlee Cunsolo Willox, McGill University)	Mental health issues have been strengthened by additional text in several places: (1) last sentence at end of first paragraph under “Indirect impacts of climate change on the health of Arctic residents”28.2.4.1.2, and (2) the entire final paragraph of the section is devoted to mental health. Also, there are several references to mental or neurological impacts from different climate-related situations throughout the section.
372	37259	28	30	14	0	0	Section 28.2.6. Economic Sectors I wonder if there should be some mention of the potential for the expansion/development of hydroelectric projects in Arctic regions. Apart from inundations of land to create reservoirs by building dams, and disturbances to river ecosystems, these projects also change the hydrological cycle of delivery of freshwater to the coastal/marine ecosystems, since seasonal requirements for electrical power generally mean that water is released from river systems in winter, rather than during the natural run-off period (spring/summer). This can impact ice-dynamics and (I would think) nutrient supplies. This is not really my area of expertise, but it seems to me that warming in the Arctic might increase the potential for development of more hydroelectric projects in the search for “green energy”, which might not be as “green” as we would like to think. (Erica Head, Fisheries and Oceans Canada)	Noted. Due to space limitations not included.
373	51823	28	30	14	0	0	Section 28.2.5. The author team could consider merging this section with 28.2.6, potentially using this section as introductory material for 28.2.6. (Katharine Mach, IPCC WGII TSU)	The two sections have been merged.
374	44688	28	30	18	0	27	It is desirable to add the information about recent agreements and discussion about dividing the Arctic territory between countries and the speculation of Russian authorities about Russia's rights concerning Arctic (Maria Ananicheva, Institute of Geography)	Acknowledged
375	41967	28	30	26	30	26	Not only indigenous people but also non-native population in these regions are involved in subsistence activities (Vladimir Romanovsky, University of Alaska Fairbanks)	Acknowledged. But the section deals primarily with indigenous people. 28.2.6 p. 55, L40 (JL CPH) Replaced “indigenous” with “both indigenous and non-indigenous”,
376	37593	28	30	32	30	34	For the sentence beginning with, "It is projected..." These conditions have already been observed. A more accurate sentence could mention that these conditions are observed and projected to continue. (Jon Rosales, St. Lawrence University)	Replaced sentence on p. 55. L. 44 (JL CPH) with “Significant impacts on the ability of key subsistence marine and terrestrial species are being observed and are expected to continue as climate continues to change, and the ability to maintain ones economic well-being may be effected.”
377	37594	28	30	36	0	0	In addition to the statement on herders, whalers and walrus hunters are telling us the same thing with our AKSIK project (www.aksik.org). (Jon Rosales, St. Lawrence University)	Added, p. 55, L.36 “some” in front of “Herders” and following “herders” added the following: “whalers, and walrus hunters”. Also, add into reference list at end of this sentence: (Ignatowski and Rosales, 2012: www.AKsik.org.)
378	40988	28	30	39	0	0	You need a separate header for the Antarctic (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	Noted, but not changed because this is only an introduction. Need to conserve space due to strict space limitations.
379	41804	28	30	43	0	43	Following up on the above concern, please see list of relevant publications discussing the implications of climate change for the Arctic tourism sector (listed in order of relative importance/relevance to the chapter). (Daniel Scott, University of Waterloo)	A section dedicated to tourism is not included due to strict space limitations. Tourism is covered in the recent SWIPA report.
380	51824	28	30	47	0	0	Section 28.2.6.1.1. For all likelihood terms assigned in this section, the author team should ensure that there is a probabilistic basis for their assignment. (Katharine Mach, IPCC WGII TSU)	Noted. To be finalized in team discussions.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
381	40989	28	30	47	31	7	The assumption that agriculture will not be significant is probably true at least for the near term in the northern parts of the arctic. The challenges are not only climate/weather but also soil fertility (the glaciers scraped away most of the good stuff in areas otehr than Beingia and soil development is slow in cold climates) and in many cases water. However for years the Klondike (in Beringia which wasn't galciated) was almost self sufficient in the production of food stuffs. The use of community greenhouses is becoming increasingly common and the application of new technologies including the utilization of bio char and community composting for soil development, the utilization of waste heat to warm greehouses, the utilization of hydroponics, the utilization of waste heat from other buidings and the application of LED lighting that is specifically tuned to meet the photosynthetic needs may result in more energy efficient local food production. The high costs of delivering food stuffs from outside make local agricultural pursuits more competitive. Examples are projects at the Yukon Research Centre at Yukon College - the Greenhouse is supplying year round salad vegetables for the college cafeteria http://www.yukoncollege.yk.ca/research/projects/northern_greenhouse_research_project and bio char http://www.yukoncollege.yk.ca/research/projects/effectiveness_of_biochar_on_northern_soils . This type of initiative is occurring elsewhere with community greenhoses established in many communiteis includieng in association with the Nunavut Research Institute in Iqaluit (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	While these are good points and useful examples, this discussion has not been included due to strict space limitations.
382	44689	28	31	15	0	0	Decrease of glacier melt water discharge in some mountain regions has caused deterioration of freshwater quality (the Ural mountains, e.g.). The river runoff from the mountains is less clean. (Maria Ananicheva, Institute of Geography)	Line#?
383	43665	28	31	21	31	39	Much of the information given in this para could be included in the section on projections 28.3.5.1. on page 50 (Marjut Kaukolehto, University of Helsinki)	Text has been moved to 28.3.5.1 This section was shortened. Sentences were added indicating the difficulty of differentiating Climate Change from Fishery induced change.
384	44690	28	31	53	0	0	Scientific tourism is missing as well (Maria Ananicheva, Institute of Geography)	Acknowledged. Not included due to strict space limitations.
385	40990	28	32	5	32	25	The rapid decrease in the size of the Chinook (King) Salmon run on the Yukon River over the last decade is having a significnat impact on many Alaskan communiteis (40-50) along the river which have no road access. It is also having an impact on Yukon First Nations. The commercial fishery in the Yukon has been closed for several years. This year 2012 all indications are that the run has been reduced to a level that Alaska has imposed a total ban on harvesting for domestic purposes. The cause is still unclear though it appears that a combination of historic harvesting levels, off shore by catch and environment. The following web site reports on the situation in early July- there has been considerable updated information from the Yukon and Alaska since and by the time the WG is down to reviewing these comments more may be known http://www.pac.dfo-mpo.gc.ca/yukon/docs/2012/yukon/2012-07-05.pdf . There is no mention of the inland fishery - example Great Slave Lake or Fresh Water Aquaculture- example the Icy Waters Arctic Char fish farm which exports products http://www.icywaters.com There has also been work done on how a general warming is influencng fish species of commercial, subsistence or otherwise of economic significance (example sport fishing and outfitting). An example is Mackensie- Grieve's work on Lake trout http://www.ingentaconnect.com/content/nrc/cjfas/2006/00000063/00000004/art00007 and von Finster's work on how climate is impacting glaciers which in turn can effect spawning success of anadromous fish http://www.taiga.net/yourYukon/col466.html (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	Good example, but could not be included due to strict space limitations.
386	44691	28	32	11	0	0	(Mokhow and Khon, (Maria Ananicheva, Institute of Geography)	Noted
387	36644	28	32	11	32	12	restructure this citation (Jeff Ridley, UK Met Office)	Fixed
388	36645	28	32	17	32	18	restructure this citation (Jeff Ridley, UK Met Office)	Fixed
389	36646	28	32	19	32	19	restructure this citation (Jeff Ridley, UK Met Office)	Fixed
390	36647	28	32	21	32	21	restructure this citation (Jeff Ridley, UK Met Office)	Fixed
391	37595	28	32	22	0	0	An example from Reist et al. (2006) should be included in this sentence. (Jon Rosales, St. Lawrence University)	This section was shortened, due to page limitations, detailed reports on specific systems was not possible.
392	36651	28	32	28	0	0	Any reference to invasive species carried by shipping (as mentioned in the Antarctic section)? (Jeff Ridley, UK Met Office)	Will consider this point
393	36652	28	32	28	0	0	Impact of bilge dumping, oil spills, gas-flaring, permafrost melt damage to storage tanks? (Jeff Ridley, UK Met Office)	Consider including. Looking for references.
394	36688	28	32	28	0	0	Section 28.2.6.1.4 - Note that marine transportation supports mining development as well as oil and gas development. In northern Canada, potential mining development have proposed to ship supplies for construction and operation by sea to ports to be constructed for these developments. Mining products may also be shipped to market by sea (Examples include proposed Mary River Iron mine on Baffin Island currently going through environmental hearings and other proposed projects along the Coronation Gulf). See for eg: Roujanski, V.E., Jones, K.W., Haley, J., Hawton, K., and Fitzpatrick, C. 2010. Some permafrost-related terrain features and associated design considerations along the proposed southern rail alignment, Mary River Project, Baffin Island, Nunavut. In GEO2010, 63rd Canadian Geotechnical Conference & 6th Canadian Permafrost Conference Calgary. GEO2010 Calgary Organizing Committee, pp. 493-499. http://136.159.147.171/scripts/minisa.dll/5028/10/3/73058?RECORD (Sharon Smith, Geological Survey of Canada)	Has been included in section 28.2.6.1.4.
395	40991	28	32	28	33	9	While the section is entitled marine shipping I see no where in the text reference to shipping seasons on rivers and lakes. This is commercially important on some rivers (mostly tug and barge) and is important for traditonal activites. One of the emerging issues appears to be water levels (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	Acknowledged. Looking for literature to incorporate here.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
396	44693	28	32	31	0	0	Maslanik et al, 2011, July "Geophysical research letters" Distribution and trends in Arctic sea ice age through spring 2011" - the new data about sea ice extent in various basins that explains the perspectives for shipping in the Arctic (Maria Ananicheva, Institute of Geography)	Noted.
397	36648	28	32	33	32	33	unnecessary embedded brackets (Jeff Ridley, UK Met Office)	Removed.
398	37725	28	32	41	0	0	I think there is a need to consider how change in shipping may reinforce meting trends. Add:? This added shipping and economic activity will increase the amount of black carbon and reinforce warming trends in the region (Lack and Corbett 2012, Levitsky 2011). The added warming and ice-melt could lead to additional economic activity. [Lack, D. A.; Corbett, J. J., 2012: Black carbon from ships: a review of the effects of ship speed, fuel quality and exhaust gas scrubbing Atmospheric Chemistry and Physics Discussions, 12(1)3509-3554] [Levitsky, M., 2011: Black Carbon and Climate Change: Considerations for International Development Agencies. World Bank Washington, DC. 40 pp.] (George Backus, Sandia National Laboratories)	Checking references.
399	49230	28	32	49	32	50	please integrate key findings related to this aspect into the executive summary together with page 33, line 3-5. (Oyvind Christophersen, Climate and Pollution Agency)	Has not been included for the SOD due to strict space limitations.
400	49231	28	32	54	32	54	Check reference: "(p.5318)" is not understood (Oyvind Christophersen, Climate and Pollution Agency)	Was an error. Removed.
401	36649	28	32	58	32	58	what does p.5318 refer to? (Jeff Ridley, UK Met Office)	Was an error. Removed.
402	36689	28	33	12	0	0	Section 28.2.6.1.5 - This section could be improved by including reports that do comment on specific techniques that might be utilized to deal with issues related to thawing permafrost. Documents produced by the Canadian Standards Association (CSA) and Transportation Association of Canada (TAC) are probably relevant. Refs: Canadian Standards Association (2010) Technical Guide - Infrastructure in permafrost: a guideline for climate change adaptation. CSA Special Publication Plus 4011-10. Transportation Association of Canada (2010) Guidelines for development and management of transportation infrastructure in permafrost regions. May 2010 TAC, Ottawa (Sharon Smith, Geological Survey of Canada)	Noted. Problem of space limitation.
403	40992	28	33	12	33	29	This section is to simplistic. Warming and thawing permafrost is more of an issue that suggested here. Also the cost of adaptation can be exhorbitant for small communities or individuals and also puts extra barriers on business. Examples of recent work National Round Table on the Economy and Environment http://nrtee-trnee.ca/climate/true-north , CSA http://shop.csa.ca/en/canada/infrastructure-and-public-works/plus-4011-1st-ed-pub-2010/invnt/27030762010/ Northwest Territories http://www.pws.gov.nt.ca/pdf/publications/Thermosyphon%20Foundations%20in%20warm%20permafrost%20.pdf and the Inuvik (community population of 3500) School http://www.pws.gov.nt.ca/pdf/publications/Thermosyphon%20Foundations%20in%20warm%20permafrost%20.pdf & http://www.nnsi.com/business/pdfs/construction/Inuvik's%20new%20super%20school%20nears%20completion.pdf and hignways http://www.tac-atc.ca/english/resourcecentre/readingroom/conference/conf2009/pdf/Reimchen.pdf Some of these references deal with the development and application of current solutions but in many cases even these adaptations are being projected to have a shorter life expectancy than similar projects being built elsewhere and all have high costs. (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	Comment will be acted upon, but keeping space limitation in mind.
404	41968	28	33	18	33	20	Not clear reference to permafrost. What does it mean? Also, permafrost thaws, not melts! (Vladimir Romanovsky, University of Alaska Fairbanks)	Acknowledged.
405	44694	28	33	25	0	0	ISOPE-2009, Osaka, Japan, June 21-26, 2009 Buzin I.V. Spreading of the multiyear ice in the Barents Sea---2. Kubyshkin N.V., Andreev O.M., Borodulin V.V., Glazovsky A.F., Gudoshnikov Yu.P., Zubakin G.K., Macheret Yu.Ya., Skutin A.A. Characteristics of icebergs in their calving sites in Russian Arctic: results of airborne and direct studies during IPY 2007/08. POAC-2009, Lulea, Sweden, June 9-12, 2009 Nesterov A., Sagerup T., Gudoshnikov Yu., Liferov P. Ice drift in the northeastern Barents Sea: measurements and simulation (Maria Ananicheva, Institute of Geography)	Reference suggestions noted.
406	36690	28	33	27	33	29	Smith and Risebrough (2010) should be cited rather than Prowse et al (2009). Smith & Riseborough (2010) is more recent and utilizes observations and modelling to demonstrate the relative role of ground disturbance and climate warming and the increasing importance of climate warming over longer time scales. If the IPCC is to present a synthesis of the most recent research and to report advances that have been made, then Smith & Riseborough (2010) should be cited as it was one of the first papers to look at the relative impact of the two forcing factors. (note that the statement in Prowse et al 2009, which it self is an excerpt of Furgal &Prowse 2008, was based on earlier observational evidence of which I am very much familiar but not the more advanced work). Combined effects of climate warming and impacts related to infrastructure itself were also explored to some extent by Fortier et al. 2011. Ref: Smith SL, Riseborough DW (2010) Modelling the thermal response of permafrost terrain to right-of-way disturbance and climate warming. Cold Regions Science and Technology 60:92-103. doi:10.1016j.coldregions.200908.009 Fortier R, Leblanc A-M, Yu W (2011) Impacts of permafrost degradation on a road embankment at Umiujaq in Nunavik (Quebec), Canada. Canadian Geotechnical Journal 48:720-740 (Sharon Smith, Geological Survey of Canada)	Reference has been included
407	44695	28	33	28	0	0	These papers can be useful for the description of Resource exploration on the Arctic shelf in Russia (Maria Ananicheva, Institute of Geography)	Acknowledged

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
408	36691	28	33	32	0	0	section 28.2.6.1.6 - It is suggested that the section title be revised to "Resource exploration and development". It is important to note that the development of these resources including hydrocarbon production and transportation, mine operation etc. may also be effected by a changing climate. Following mine closure there may continue to be impacts associated with climate change such potential issues related to integrity of mine waste disposal sites dependent on frozen conditions (these are probably the most important impacts of a changing climate with respect to resource development). It would be good if there was a brief discussion of the issues associated with resource development. It is unclear why this has been excluded from the discussion. Information regarding some of the issues can be found in Hayley & Horne (2008), Prowse et al. (2009 - already cited in chapter), SWIPA permafrost chapter, and also studies done on vulnerability of mining in Nunavut by Golder (2012) and mining in general by NRCan MEND program. Refs: Hayley, D.W., and Horne, B. 2008. Rationalizing climate change for design of structures on permafrost : a Canadian perspective. In Proceedings of Ninth International Conference on Permafrost. Edited by D.L. Kane and K.M. Hinkel. Fairbanks. Institute for Northern Engineering, University of Alaska Fairbanks, Vol.1, pp. 681-686. Golder (2012) Vulnerability Assessment of the Mining Sector to Climate Change Task 1 Report. Prepared for Nunavut Regional Adaptation Collaborative. Available at: http://www.climatechangenunavut.ca/en/project/nunavut-regional-adaptation-collaborative ; Mine Environmental Neutral Drainage (MEND) Program (2011) Climate change and acid rock drainage - risks for the Canadian mining sector, MEND 1.61.7. http://www.mend-nedem.org (Sharon Smith, Geological Survey of Canada)	Section title has not been renamed. Information provided by reviewer has not been included due to strict space limitations.
409	40993	28	33	32	34	2	Focus on the arctic and not the subarctic where much of this activity- especially mining- has and will continue to occur. Challenges are similar with transport being a major issue as are issues of qualified workforces, energy supply and environmental protection. (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	Noted. Definition of arctic region used for this chapter includes regions of the sub Arctic
410	49232	28	33	42	33	45	please integrate key findings related to this aspect into the executive summary (Oyvind Christophersen, Climate and Pollution Agency)	Will consider including. Issue of space limitation.
411	43666	28	33	48	33	49	Rephrase the sentence for clarity and remove repetition: "Almost all of the explored gas deposits and 90% of the explored oil 49 deposits are located in the Russian part of the Arctic regions" to read: "Almost all of the gas deposits and 90% of the oil deposits explored in the Arctic are located in Russia. (Marjut Kaukolehto, University of Helsinki)	Done
412	51825	28	33	53	33	53	"likely" -- If this term is being used per the uncertainties guidance for authors (reflecting a probabilistic basis for its assignment), it should be italicized. Casual usage of this reserved likelihood term should be avoided. (Katharine Mach, IPCC WGII TSU)	Noted
413	37598	28	34	0	0	0	Section 28.2.6.1.7 should be expanded to include more literature on Inuit subsistence economy. A quick Google Scholar search reveals a few thousand articles with the search terms Inuit and subsistence between 2005 and 2010 (Jon Rosales, St. Lawrence University)	Efforts will be made to incorporate material on Inuit subsistence economy, but must consider space limitations.
414	43667	28	34	2	0	0	Emissions of what substances? (Marjut Kaukolehto, University of Helsinki)	Gas emissions. Fixed in SOD text.
415	40994	28	34	5	34	48	Again the sub arctic - in North America represented by Cree, Athabaskan, Gwitchen, Innu etc not represented in the text (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	Acknowledged.
416	37596	28	34	8	0	0	In the sentence, "For Inuit..." you could add faster sea ice retreat in the spring. (Jon Rosales, St. Lawrence University)	Has been included
417	48961	28	34	18	0	48	please check carefully the content of each reference given here. (Svein Disch Mathiesen , International Centre for Reindeer Husbandry)	Acknowledged
418	43668	28	34	32	34	34	The sentence should be completed by adding a word extraction "...intense pressure to develop oil, gas and minerals EXTRACTION in the North, the Arctic regions are becoming..." (Marjut Kaukolehto, University of Helsinki)	Done "extraction" does not quite fit sentence flow
419	37597	28	34	33	0	0	In referring to the statement "far more accessible to humans..." This statement should be qualified. These changes in fact make areas less accessible to traditional hunters who hunt on sea ice and snow pack. The statement may be true for humans interested in industrial development. (Jon Rosales, St. Lawrence University)	Change sentence per suggestion to read: "...gas and minerals extraction in the north, some Arctic regions are becoming far more accessible to humans and industrial development resulting in additional sources of increasing and irreversible loss of pasturelands. (Refs) Conversely, other parts of the Arctic are becoming less accessible for traditional hunters who hunt on the sea ice of snow pack."
420	39102	28	34	53	35	8	Cite Ainley and Blight 2008, Fish and Fisheries 9, 1-26 for review ecological repercussions of fishing in the Southern Ocean. See also Ainley, D.G. & Brooks, C. (2012). Exploiting the Southern Ocean: Rational use or tragedy of the commons? In Liggett, D., Hemmings, A.D. & Steel, G. (Eds.) Exploring Antarctic Values. Christchurch, New Zealand: University of Canterbury, Gateway Antarctica Special Publication Series. an (Eric Woehler, University of Tasmania)	We thank the reviewer for these references. They will be considered.
421	43669	28	35	3	0	0	Use the same word, either Section or Chapter, throughout the chapter (and report). (Marjut Kaukolehto, University of Helsinki)	Will be fixed in the editing.
422	51826	28	35	4	35	4	"likely" -- If this term is being used per the uncertainties guidance for authors (reflecting a probabilistic basis for its assignment), it should be italicized. Casual usage of this reserved likelihood term should be avoided. (Katharine Mach, IPCC WGII TSU)	Noted.
423	36650	28	35	10	35	10	SC-CAMLR not in reference list. Is this the same as CCAMLR quoted later on this page (also not referenced)? (Jeff Ridley, UK Met Office)	revised
424	40995	28	35	14	35	15	There is a discrepancy between the Total Allowable Catch reported here and the number reported on line 23 (which is considerably higher) (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	revised
425	43670	28	35	16	0	0	Current catches PER YEAR? Please be precise. (Marjut Kaukolehto, University of Helsinki)	noted

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
426	51827	28	35	23	35	39	The author team should consider reducing this material, with a focus on relevance to observed climate change impacts and vulnerabilities. It would also be helpful to clarify what the acronym CCAMLR stands for. Additionally, casual usage of the word "likely" on line 24 should be avoided. (Katharine Mach, IPCC WGII TSU)	noted
427	37599	28	35	27	0	0	What is CCAMLR? No explanation or citation provided. (Jon Rosales, St. Lawrence University)	clarified
428	40999	28	35	36	0	0	Glossary Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR). The text uses the full name on the next page on line 35 (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	clarified
429	39103	28	35	44	35	47	Cite Jabour (accepted). Strategic management and regulation of Antarctic tourism. In Tin T, Liggett D, Maher P and Lamers M (eds) The future of Antarctica [prov book title] Springer current review of Antarctic tourism and Woehler et al (accepted) Human Impacts to Antarctic Wildlife: Predictions and Speculations for 2060. In Tin T, Liggett D, Maher P and Lamers M (eds) The future of Antarctica [prov book title] Springer re broad descriptions of human impacts. (Eric Woehler, University of Tasmania)	Will consider these references.
430	40996	28	35	45	0	0	More up to date statistics at http://iaato.org/tourism-statistics (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	done
431	36692	28	36	2	0	0	Section 28.2.7 - Is all this information necessary? The relevance to climate change impacts and adaptation is not clear. It is also unclear what the subsections (28.2.7.1 and 28.2.7.2) have to do with governance. There is a real problem with organization here. (Sharon Smith, Geological Survey of Canada)	We were asked in the Plenary approved chapter outline to discuss governance.
432	43671	28	36	2	0	0	Chapter 28.2.7. governance..: This could be independent second order chapter (28.X.) since it deals with both potential effects and adaptations in human systems in the Arctic. Other option is that it could be part of 28.4. (Marjut Kaukolehto, University of Helsinki)	We will discuss the possibility of moving this to the adaptation section.
433	48962	28	36	4	0	54	Dr Carina Kesitalo has published several books and articles about climate change and multilevel governance. which should be included in this section. (Svein Disch Mathiesen , International Centre for Reindeer Husbandry)	Noted
434	51828	28	36	4	36	5	The author team may wish to revisit the phrasing of this statement to ensure a formulation that is not prescriptive. (Katharine Mach, IPCC WGII TSU)	Will redraft this sentence
435	40997	28	36	9	0	0	Suggest it would be useful to tell the reader the current extent of the treaty participation http://www.antarctica.ac.uk/about_antarctica/geopolitical/treaty/ (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	Noted
436	39104	28	36	9	36	15	Excellent contemporary descriptions of Antarctic environmental and policy, management etc in Hemmings, A.D. (2011a). Environmental Law – Antarctica. In K., Bosselmann, D.S., Fogel & J.B., Ruhl (Eds.) The Law and Politics of Sustainability (pp. 188-194). Volume 3 of the Berkshire Encyclopedia of Sustainability. Great Barrington, MA, USA: Berkshire. Hemmings, A.D. (2011b). Why did we get an International Space Station before an International Antarctic Station? The Polar Journal, 1, 5-16. Hemmings, A.D. & Kriwoken, L.K. (2010). High level Antarctic EIA under the Madrid Protocol: state practice and the effectiveness of the Comprehensive Environmental Evaluation Process. Journal of International Environmental Agreements: Politics, Law & Economics, 10, 187-208. Hemmings, A.D. & Roura, R. (2003). A square peg in a round hole: Fitting impact assessment under the Antarctic Environmental Protocol to Antarctic tourism. Impact Assessment and Project Appraisal, 21, 13-24. (Eric Woehler, University of Tasmania)	Noted references.
437	37600	28	36	17	36	27	It should be mentioned that the role of the Arctic Council is increasing in importance as pointed out at the International Polar Year 2012 conference in Montreal. (Jon Rosales, St. Lawrence University)	Value judgement but will try to reflect this sense. Similar sentiments have been made with reference to the Antarctic Treaty.
438	40998	28	36	19	0	0	Not really Indigenous Arctic Communities but Indigenous peoples' organizations http://www.arctic-council.org/index.php/en/about-us/permanentparticipants (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	Noted
439	43672	28	36	22	0	0	Open the acronyms (Marjut Kaukolehto, University of Helsinki)	Noted
440	51829	28	36	54	36	54	"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. Casual usage of this reserved likelihood term should be avoided. (Katharine Mach, IPCC WGII TSU)	Will redraft this sentence.
441	36693	28	37	7	0	0	Section 28.2.7.1 - For the most part this section presents observations and further documentation of changes that have occurred in various environmental components. It would make more sense to include these observations with other documentation from the literature in a section providing a summary of changes that have taken place. (Sharon Smith, Geological Survey of Canada)	This comment was taken into account during rewrite of this section
442	47999	28	37	7	37	0	I am very happy to see this section in this report, and I want to applaud the authors for going further with this section than previous AR reports to really acknowledge things such as, 'The perception of change at the community level can be as important as scientifically detectable or measurable change...' (lines 16-17, p. 38). It's nice to see the strengthening of language to really show the importance of Indigenous knowledge and wisdom. What I think is missing from this section, however, is perhaps a statement that talks explicitly about working in partnership with Indigenous populations as we move forward with climate change adaptation, research, mitigation, etc. in the coming years. Yes, it's important to value the wisdom, but we also need to forge meaningful, lasting, sustainable relationships (here I am thinking of the work of Sheri Gearheard in particular). An explicit statement to this effect would really help to solidify what is being said in this section. (Ashlee Cunsolo Willox, McGill University)	Added language into text
443	51830	28	37	19	37	19	The author team may wish to revisit the phrasing of the statement to ensure a formulation that is not prescriptive. (Katharine Mach, IPCC WGII TSU)	Fixed this in text

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
444	52088	28	37	40	37	46	For the definitional discussion here, the author team should also consider providing reference to the definition of "traditional knowledge" in the glossary for the report. (Katharine Mach, IPCC WGII TSU)	Sent definition of "traditional knowledge" to glossary
445	47193	28	37	46	37	46	Now peer-reviewed and published as (Nakashima et al 2012): Nakashima, D.J., Galloway McLean, K., Thulstrup, H.D., Ramos Castillo, A. and Rubis, J.T. 2012. Weathering Uncertainty: Traditional Knowledge for Climate Change Assessment and Adaptation. Paris, UNESCO, and Darwin, UNU, 120 pp. (Douglas Nakashima, UNESCO)	This reference was fixed in final version of the chapter
446	47194	28	37	50	37	50	Now peer-reviewed and published as (Nakashima et al 2012): Nakashima, D.J., Galloway McLean, K., Thulstrup, H.D., Ramos Castillo, A. and Rubis, J.T. 2012. Weathering Uncertainty: Traditional Knowledge for Climate Change Assessment and Adaptation. Paris, UNESCO, and Darwin, UNU, 120 pp. (Douglas Nakashima, UNESCO)	Updated reference
447	41000	28	37	51	37	54	Also useful for providing insight into historical environmental and landscape conditions and significant environmental events. In many cases awareness of this information helps scientists interpret findings or even alerts them to the possibility of some signal in the proxy record. (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	Inserted "Indigenous knowledge is also useful for providing insight into historical environmental and landscape conditions and significant environmental events." P. 37, L53 at end of sent ending in "observations emerge."
448	37613	28	37	52	37	53	Ignatowski and Rosales. 2012. The Local and Professional Science of Climate Change in Two Subsistence Alaskan Villages. Submitted. Could be added to support the phrase "..., and this is precisely the scale at which indigenous observations emerge." (Jon Rosales, St. Lawrence University)	Inserted "(Rosales and Ignatowski, 2012)" at end of sentence ending with "Observations emerge".
449	47195	28	38	7	0	0	Now peer-reviewed and published as (Nakashima et al 2012): Nakashima, D.J., Galloway McLean, K., Thulstrup, H.D., Ramos Castillo, A. and Rubis, J.T. 2012. Weathering Uncertainty: Traditional Knowledge for Climate Change Assessment and Adaptation. Paris, UNESCO, and Darwin, UNU, 120 pp. (Douglas Nakashima, UNESCO)	Fixed reference
450	51831	28	38	29	38	29	It would be helpful to clarify the timeframe relevant to the described "recent years." (Katharine Mach, IPCC WGII TSU)	This was taken into account in final version of the chapter
451	36653	28	38	37	29	2	reformat citations (Jeff Ridley, UK Met Office)	Fixed reference
452	36654	28	38	37	38	40	Oddly placed section here. Move to page 20 to include in a new specific section on fire. (Jeff Ridley, UK Met Office)	Moved this section and put together with new sentence about fire...see response to #21,22 (point #2) to end of section 28.2.6.1.7
453	37615	28	38	37	38	49	In addition to the items listed in this paragraph related to sea ice, fires, and temperatures, we found in Ignatowski and Rosales 2012 (Ignatowski and Rosales. 2012. The Local and Professional Science of Climate Change in Two Subsistence Alaskan Villages. Submitted) that TEK and professional science reported in major assessment reports also find agreement on more variable and inconsistent weather; summere and fall seasons lasting longer while winters lasting shorter; more intense storms with stronger winds, waves, flooding, and erosion; more rain, even in the winter; stronger winds; higher high tides and higher low tides; more noticeable erosion of tundra on coastlines and riverbanks; tundra lakes disappearing; less snow pack on the tundra; more freshwater runoff into rivers; and new animal and insect species appearing. (Jon Rosales, St. Lawrence University)	Added ref to end of sentence – (Ignatowski and Rosales, 2012)
454	37614	28	38	42	0	0	TEK of local, indigenous observations of climate change in Ignatowski and Rosales 2012 (reference above) reveal the same findings in the two Alaskan villages we study. Citation: Ignatowski and Rosales. 2012. The Local and Professional Science of Climate Change in Two Subsistence Alaskan Villages. Submitted (Jon Rosales, St. Lawrence University)	Added ref to end of sentence
455	47196	28	39	11	0	0	Now peer-reviewed and published as (Nakashima et al 2012): Nakashima, D.J., Galloway McLean, K., Thulstrup, H.D., Ramos Castillo, A. and Rubis, J.T. 2012. Weathering Uncertainty: Traditional Knowledge for Climate Change Assessment and Adaptation. Paris, UNESCO, and Darwin, UNU, 120 pp. (Douglas Nakashima, UNESCO)	Corrected reference
456	41001	28	39	15	39	18	Earlier there was mention of Joint Management but not the multiplicity of governance models being implemented across parts of the north which incorporate at least some self governance aspects for aboriginal peoples, a step beyond just advisory or joint management (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	Taken into account and was to be addressed in another section
457	51832	28	39	16	39	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. Casual usage of this reserved likelihood term should be avoided. (Katharine Mach, IPCC WGII TSU)	Noted and to be fixed in final version (replace "likely" with "projected")
458	36694	28	39	21	0	0	section 28.2.7.2 - It would make sense to have a section on Adaptation and include this material as an example of adaptation. The section could also probably be shortened. (Sharon Smith, Geological Survey of Canada)	Section was shortened and some material moved to Adaptation section
459	51833	28	39	21	0	0	Section 28.2.7.2. The author team should consider and reduce repetition with earlier sections, insuring a focus on governance. For example, the paragraph at the end of this page is largely repeated from page 34, and the 2nd paragraph on page 40 is similarly highly redundant. (Katharine Mach, IPCC WGII TSU)	Section was shortened, repeated material was removed
460	41969	28	39	23	40	51	In this section there are many repetitions from the previous sections (rain on snow, impact of industrial developments etc) (Vladimir Romanovsky, University of Alaska Fairbanks)	Section was shortened, repeated material was removed
461	43673	28	39	45	40	12	This paragraph have considerable redundancy with the texts given on page 34 chapter 28.2.6.1.7. Consider removing repetitions and rather using cross reference and shorten the text here. (Marjut Kaukolehto, University of Helsinki)	Removed redundant material
462	48963	28	40	31	0	35	Please include reference to Vistnes and Nellmann as given abow. (Svein Disch Mathiesen , International Centre for Reindeer Husbandry)	reference added
463	37601	28	40	38	0	0	No reference listed for Forbes 2000 (Jon Rosales, St. Lawrence University)	Reindeer & CC section reference fixed
464	43674	28	40	38	0	0	The reference Forbes is missing from the reference list and perhaps Gautier et al 2009 would be a better reference here? (Marjut Kaukolehto, University of Helsinki)	references fixed

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
465	36657	28	41	1	0	0	Both AR4 and AR5 (WG1 Ch14) models predict a strengthening of the hydrological cycle in the Arctic with increased rainfall and river flow. Increased temperatures leads to greater evapotranspiration. However, models are widely divergent in the quantitative details of projected Arctic hydrological change (Holland et al., 2007), underscoring the lingering uncertainty in this dimension of the regions changing climate. (Jeff Ridley, UK Met Office)	Noted. This is WG1 domain
466	37260	28	41	1	0	0	Section 28.3. Key projected impacts and vulnerabilities under different climate pathways. 28.3.1. Hydrology and freshwater ecosystems. 28.3.1.1. Arctic There was very little in this section about the freshwater biota, or the potential effects of increasing acidification. Are there no issues here? (Erica Head, Fisheries and Oceans Canada)	Noted
467	51877	28	41	1	0	0	Section 28.3. In further development of the chapter, the author team should consider overlap between parallel subsections of 28.2 and 28.3, reducing it as appropriate for the scope of each section. Overall, 28.2 and 28.3 would benefit from further distinction of observed impacts and vulnerabilities (treated in 28.2) and those projected for the future (assessed in 28.3). (Katharine Mach, IPCC WGII TSU)	Chapter has been edited, and overlaps have been addressed
468	36656	28	41	1	42	38	What about impacts from sea level rise? Salinification of low-lying marshes, increased coastal erosion due to waves as sea ice retreats. (Jeff Ridley, UK Met Office)	Noted
469	41972	28	41	3	0	0	Section 28.3.1. Very important aspect of the dynamics of thermokarst lakes (appearance of new lakes and drainage of existing lakes) and its ecological consequences is completely missing from this section (Vladimir Romanovsky, University of Alaska Fairbanks)	The authors agree that a statement that builds on similar impacts that have already been identified in Section 28.2.1. would be useful to reiterate here in terms of future projected changes. So that such a statement is well founded re: projections of future changes, there is firstly a reference made to WG1 CH4, which deals with future projected changes in the cryosphere, followed by a deductive statement that, given enhanced permafrost that thawing in the future, those hydro-ecological changes already identified in 28.2.1. are also likely to be amplified in the future.
470	44696	28	41	6	0	0	hyporheic - spelling! (Maria Ananicheva, Institute of Geography)	It is thought that this comment refers to p. 41 L 17. Spelling is correct. The hyporheic zone refers to the area beneath and alongside a stream/river bed, where there is mixing of shallow groundwater and surface water. This item will be proposed for inclusion in the Assessment glossary of terms.
471	52653	28	41	7	41	26	Biological/ecosystem effects of permafrost thawing , especially with emphasis on studies on specific key species or habitats, could be expanded? (Else Marie Løbersli, Norwegian directorate for nature management)	The authors would very much like to expand this and a number of other items. Unfortunately, space limitations preclude a lengthier discussion. As an alternative, reference is made to the ecological effects already discussed in 28.2.1.1, nothing that these would continue to occur as projected permafrost thaw (link to WG1 Ch4) continues. Note response to similar point in #469.
472	51834	28	41	25	41	25	"likely" -- If this term is being used per the uncertainties guidance for authors (reflecting a probabilistic basis for its assignment), it should be italicized. Casual usage of this reserved likelihood term should be avoided. (Katharine Mach, IPCC WGII TSU)	Text has been reworded.
473	44697	28	41	28	0	0	delta-riparian - may be more simple - delta territory? (Maria Ananicheva, Institute of Geography)	It is thought that this comment refers to P 41 L 36. The compound adjective delta-riparian has been specifically used here to refer to the land areas on the banks of delta channels as opposed to the in-channel zone. The same would not be connoted by using the compound adjective "delta-territory", which would include both zones.
474	51835	28	41	29	41	31	The author team should consider specifying as appropriate the relevant climate/socio-economic scenarios for these projections. (Katharine Mach, IPCC WGII TSU)	Reference is made to the SRES-A2 scenario employed by the cited reference, which has also been corrected.
475	41970	28	41	38	41	38	What is "stamukhi lakes"? (Vladimir Romanovsky, University of Alaska Fairbanks)	Stamukhi lakes occur near large river inflows along the Arctic coastline, and are the result of freshwater retention behind the thick barrier of rubble ice (stamukhi) that forms at the outer limit of land-fast sea ice. Information on these can be found in the cited literature of this sentence. The word will be proposed for inclusion in the Assessment Report overall glossary of terms.
476	41971	28	41	42	41	42	I suggest replacing "...a study of hypothetical 20-m..." with "...a modeling of hypothetical 20-m..." (Vladimir Romanovsky, University of Alaska Fairbanks)	Suggestion accepted and text changed.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
477	36695	28	41	42	41	49	References are required for the information presented in this paragraph. Brown and Duguay (2010, 2011) may be relevant to this discussion. Refs: Brown L, Duguay CR (2010) The response and role of ice cover in lake-climate interactions. Prog Phys Geog 34(5):671-704. doi:10.1177/0309133310375653 Brown L, Duguay CR (2011) The fate of lake ice in the North American Arctic. The Cryosphere 5(4):1775-1834 (Sharon Smith, Geological Survey of Canada)	Citation to Dibike et al. (2011) has been included and a reference to the SRES A2 scenario noted. Although there are numerous papers with regional foci that deal with modelling of lake ice cover, IPCC space limitations preclude listing, assessing and intercomparing all of them. Moreover, predictions of the basic physical change in ice cover is in the mandate of WGI CH 4. This WGII chapter is to focus on the related impacts. Hence, this Dibike et al. (2011) reference was selected here because of its discussion of related water temperatures and thermal stratification, and because it is hemispheric rather than regional in focus.
478	51836	28	41	42	41	49	Citations should be provided for this paragraph. Additionally, the relevant climate/socio-economic scenarios could be specified. (Katharine Mach, IPCC WGII TSU)	Citation to Dibike et al. (2011) has been included and a reference to the SRES A2 scenario noted.
479	51837	28	41	51	41	51	"likely" -- If this term is being used per the uncertainties guidance for authors (reflecting a probabilistic basis for its assignment), it should be italicized. Casual usage of this reserved likelihood term should be avoided. (Katharine Mach, IPCC WGII TSU)	Text has been modified to eliminate the likelihood term and the sentence now reads "The loss or reduction in duration of ice cover on lakes and corresponding changes in their thermal regimes can affect a number of aquatic processes."
480	51838	28	42	1	42	35	"likely" on lines 1 and 35, "unlikely" on line 30 -- If this term is being used per the uncertainties guidance for authors (reflecting a probabilistic basis for its assignment), it should be italicized. Casual usage of this reserved likelihood term should be avoided. (Katharine Mach, IPCC WGII TSU)	Text has been modified to eliminate the likelihood term and now reads "The projected changes in snow and white ice coverage can also affect levels of secondary productivity, such as in fish (e.g., Borgström and Museth, 2005; Prowse et al., 2007)."
481	51839	28	42	22	42	24	It would be helpful to clarify the baseline (in terms of year and burial rate) for this projection. (Katharine Mach, IPCC WGII TSU)	The text "as compared to rates for the approximately last half-century " has been added to give the time period on which current burial rates were calculated. Note that their rate calculations are derived from an extensive literature base of results over this ~50 yr period. The overall burial rates can be calculated from the % and related magnitude reductions.
482	35423	28	42	46	0	0	The results presented by Steig were subject of several critical commentaries, and need to be treated with some caution, and it is certainly arguable that they were based on instrumental and ice core data. There is only one study based primarily on data, and that was not particularly conclusive. Barrett, B. E., Nicholls, K. W., Murray, T., Smith, A. M., and Vaughan, D. G.: Rapid recent warming on Rutford Ice Stream, West Antarctica, from borehole thermometry, Geophys. Res. Lett., 36, doi:10.1029/2008GL036369, 2009. (David Vaughan, British Antarctic Survey)	WG1
483	51840	28	43	34	43	34	"likely" -- If this term is being used per the uncertainties guidance for authors (reflecting a probabilistic basis for its assignment), it should be italicized. Casual usage of this reserved likelihood term should be avoided. (Katharine Mach, IPCC WGII TSU)	noted
484	51841	28	43	39	43	44	It would be preferable to specify relevant citations in support of these statements. (Katharine Mach, IPCC WGII TSU)	text revised
485	35424	28	43	54	0	0	And ice shelves! E.g., Cook, A. J., and Vaughan, D. G.: Overview of areal changes of the ice shelves on the Antarctic Peninsula over the past 50 years, The Cryosphere, 4, 77-98, 2010. (David Vaughan, British Antarctic Survey)	WG1
486	51842	28	44	11	44	27	The author team should ensure a focus on projections, not observations, here. (Katharine Mach, IPCC WGII TSU)	noted
487	44698	28	44	15	0	0	again - to mention - the subglacier lakes in Antarctic (Vostok, e.g.) (Maria Ananicheva, Institute of Geography)	WG1
488	42892	28	44	26	44	27	It is not clear that fur seals have successfully taken over krill consumption left available by the reduction in the great whales. They have certainly taken over some of it, but could never replace whales, as they are central place foragers. This statement is too strong as if this is actually know. See Trivelpiece, W. Z., Hinke, J. T., Miller, A. K., Reiss, C. S., Trivelpiece, S. G. & Watters, G. M. 2011 Variability in krill biomass links harvesting and climate warming to penguin population changes in Antarctica. Proceedings of the National Academy of Sciences of the United States of America 108, 7625-7628. (Daniel Costa, University of California Santa Cruz)	text revised
489	35258	28	44	30	46	33	Section 28.3.2 comment: This bit is weak given available literature. It should deal with "forcings" in a better manner. The first sentence should read: "Arctic marine ecosystems are complex and thus predictions regarding their future functioning are challenging. But, the scientific community is in high agreement that climate change will impact marine ecosystems." (Ellen Øseth, Norwegian Polar Institute)	Noted
490	51843	28	44	32	0	0	Section 28.3.2.1. Throughout this section, the author team should use calibrated uncertainty language to characterize its degree of certainty in key findings, generally those supported by multiple lines of evidence. For the section as a whole, there may be one or several such key findings, and it may be clearest to reduce assignment of calibrated uncertainty language here accordingly. Additionally, all calibrated uncertainty language used here, including summary terms for evidence and agreement, levels of confidence, and likelihood terms, should be italicized. Additionally, wherever likelihood terms are used (for example, on lines 34, 49, 51, page 44; line 28, page 45), the author team should ensure a probabilistic basis for their assignment, avoiding casual usage of these reserved likelihood terms. Finally, on line 30 of page 45, the chapter team may wish to consider a summary term for evidence to use in place of "good evidence." (Katharine Mach, IPCC WGII TSU)	Comment accepted. Uncertainty language was added

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
491	36655	28	44	42	44	43	restructure this citation (Jeff Ridley, UK Met Office)	Accepted
492	51844	28	44	48	44	49	The chapter team may wish to consider cross-referencing the working group 1 contribution to the 5th assessment report for findings regarding this topic. (Katharine Mach, IPCC WGII TSU)	Accepted
493	42893	28	44	50	0	0	celsius is spelled incorrectly (Daniel Costa, University of California Santa Cruz)	Accepted
494	51845	28	44	50	44	53	For these statements as appropriate, the author team should consider indicating the relevant climate/socio-economic scenario, as well as the relevant time frame (for the statements on lines 51-53). (Katharine Mach, IPCC WGII TSU)	Accepted
495	37300	28	45	0	0	0	Section 28.3.2.2 comment. The following paper refers to phytoplankton blooms occurring in the ocean surrounding the Antarctic Peninsula, specifically in new bays forming as a result of glacier retreat. The following reference should be included within this section (perhaps on Page 46, Line 12): Peck, L.S., Barnes, D.K.A, Cook, A.J., Fleming, A.H. and Clarke, A. (2010) Negative feedback in the cold: ice retreat produces new carbon sinks in Antarctica. <i>Global Change Biology</i> 16(9): 2614-2623 (Alison Cook, Swansea University)	included
496	37261	28	45	4	0	0	"there is evidence that the pH of the Arctic Ocean my decline and simulation models etc." "my" should be replaced with "will". I don't think there is any question about this. The pH has already declined! (Erica Head, Fisheries and Oceans Canada)	A paragraph on ocean acidification was added to observations section.
497	49233	28	45	4	45	6	Why is AR4 scenario and not AR5, or at least more recent research on ocean acidification quoted? (Oyvind Christophersen, Climate and Pollution Agency)	We reference WG 1 now.
498	35082	28	45	8	45	21	The authors may want to refer to a newer paper that demonstrates a 20% increase in primary production in the Arctic Ocean between 1998 and 2009. Reference: Arrigo, K. R. and G. L. van Dijken, 2011. Secular trends in Arctic Ocean net primary production. <i>Journal of Geophysical Research</i> , 116, C09011, doi:10.1029/2011JC007151. (Kevin Arrigo, Stanford University)	Accepted
499	37262	28	45	9	0	0	"There is limited evidence and medium confidence that enhanced production and earlier onset light will lead to associated extension of the growing season for copepods, especially <i>Calanus hyperboreus</i> , <i>C. glacialis</i> and <i>Metridia longa</i> (Seuthe et al. 2007)." This is probably not the most useful conclusion or reference for it. I would suggest replacing the sentence thus: "There is strong evidence and high confidence that an earlier onset of primary production will advance the seasonal cycles for copepods, including <i>Calanus hyperboreus</i> , <i>C. glacialis</i> , <i>Metridia longa</i> and <i>Pseudocalanus</i> spp. (Ringuette et al. 2002). On the other hand, there is medium evidence that higher temperatures lead to reduced overall fecundity in <i>C. hyperboreus</i> (Plourde et al. 2003), and a modelling study has suggested that the growth season in a warmer Arctic will still be too short to allow the boreal species <i>C. finmarchicus</i> and <i>C. marshallae</i> to become endemic (Ji et al. 2012)." References Ji, R., C. J. Ashjian, R.G. Campbell, C. Chen, G. Gao, C. S. Davis, G.W. Cowles and R. C. Beardsley. 2012. Life history and biogeography of <i>Calanus</i> copepods in the Arctic Ocean: An individual-based modeling study. <i>Prog. Oceanogr.</i> 96, 40–56 Plourde, S., P. Joly, J.A. Runge, J. Dodson and B. Zakardjian. 2003. Life cycle of <i>Calanus hyperboreus</i> in the Iwer St. Lawrence Estuary and its relationship to local environmental conditions. <i>Mar. Ecol. Prog. Ser.</i> 255, 219-233 Ringuette, M., L. Fortier, M. Fortier, J.A. Runge, S. Belanger, P. Larouche, J.-M. Weslawski and S. Kwasniewski. 2002. Advanced recruitment and accelerated population development in Arctic calanoid copepods of the North Water. <i>Deep-Sea Res. II.</i> 49, 5081-5099 (Erica Head, Fisheries and Oceans Canada)	Some of the suggested findings were included in this draft
500	42894	28	45	16	45	19	This line is repeted and needs to be deleted (Daniel Costa, University of California Santa Cruz)	Accepted
501	37263	28	45	16	45	21	"Changes in stratification and the number of ice free days in the Arctic will ultimately lead to a build-up of pelagic secondary consumers, which will result in a reduction in the amount of carbon deposited on the sea floor (Grebmeier et al. 2006)." This is a misleading statement with an inappropriate reference. Grebmeier et al. 2006 were talking about the shallow (sub-Arctic) northern Bering Sea, not the deep central Arctic Ocean basins. Also in Line 20. "copepods like <i>C. hyperboreus</i> and <i>C. borealis</i> " And, there is no such species as <i>C. borealis</i> . Did they mean <i>C. glacialis</i> ? Anyway, I would suggest replacing the paragraph, from Line 16 with this "In the deep basins of the Arctic Ocean changes in stratification and the number of ice free days will lead to a greater drawdown of nutrients and higher pelagic primary production, but the large-bodied copepods (<i>Calanus</i> spp.) may have the capacity to graze this down and thus keep phytoplankton levels relatively low (Olli et al. 2007). In the northern Bering Sea, reduced sea-ice and warmer temperatures in the late 1990s and early 2000s led to a northward movement of benthic feeders (e.g. walrus, grey whales). This is thought to have been related to a reduced flux of particulate organic material to the benthos, because of increased pelagic grazing (Grebmeier et al. 2006). Further climate warming might lead to an extension of these conditions farther north (e.g. into the Chukchi Sea). Such changes might provide higher levels of prey for fish and baleen whales, but would likely have a negative impact on the benthic predators. In addition, some planktonic predators may suffer if the large lipid-rich Arctic <i>Calanus</i> species (<i>C. glacialis</i> , <i>C. hyperboreus</i>) are displaced by the smaller boreal forms (<i>C. finmarchicus</i> , <i>C. marshallae</i>) (e.g. Karnovsky et al. 2010)." References not in the Chapter list Karnovsky, N., A. Harding, W. Walkusz, S. Kwaśniewski, I. Goszczko, J. Wiktor Jr, H. Routti, A. Bailey, L. McFadden, Z. Brown, G. Beaugrand and D. Grémillet. 2010. Foraging distributions of little auks <i>Alle alle</i> across the Greenland Sea: implications of present and future Arctic climate change. <i>Mar. Ecol. Prog. Ser.</i> 415, 283-293 Olli, K., P. Wassmann, M. Reigstad, T.N. Ratkova, E. Arashkevich, A. Pasternak, P.A. Matrai, J. Knulst, L. Tranvik, R. Klais, A. Jacobsen. 2007. The fate of production in the central Arctic Ocean – top-down regulation by zooplankton expatriates? <i>Prog. Oceanogr.</i> 72, 84–113 (Erica Head, Fisheries and Oceans Canada)	Some of the suggested text was included in this draft
502	51846	28	45	23	45	26	The author team should consider deleting this paragraph, given the focus of the section on projected outcomes (rather than observed outcomes). (Katharine Mach, IPCC WGII TSU)	Accepted

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
503	51847	28	45	35	45	37	It would be helpful to clarify the timeframe for these expected changes. Additionally, it would be helpful to indicate more precisely what is meant by the scenarios from the 4th assessment report--which scenarios? (Katharine Mach, IPCC WGII TSU)	Many of these papers were based on projections from AR4. We thought it would be confusing to reference those scenarios in this new report.
504	49234	28	45	35	45	38	Why is AR4 scenario and not AR5, or at least more recent research on ocean acidification quoted? (Oyvind Christophersen, Climate and Pollution Agency)	Here we are citing published literature, therefore we rely on projections that used the scenarios from AR4
505	44699	28	45	48	0	0	is it appropriate to use here " medium agreement"? and " medium evidence"? (Maria Ananicheva, Institute of Geography)	Corrected
506	45198	28	45	49	0	0	Should add at least a paragraph on top predator, especially given the work on future polar bear responses (see general comment for the chapter). The key references are already included in this chapter and are discussed p13 129. (Stephanie Jenouvrier, Woods Hole Oceanographic Institution)	Noted
507	39105	28	45	53	46	4	Cite Ribic et al (2011) Deep-Sea Research II 58, 1695-1709 re seabirds and fronts in Southern Ocean, also Raymond et al 2010 (PLOS One 5(6): e10960. doi:10.1371/journal.pone.0010960 re foraging behaviours and wind fields) (Eric Woehler, University of Tasmania)	noted - revised text cites recent reviews relating to climate change impacts
508	44701	28	46	0	0	0	the section Oceanography and marine ecosystems - a little about oceanography as compared to marine ecosystems (Maria Ananicheva, Institute of Geography)	We reference WG 1 now.
509	44700	28	46	2	0	4	too many "medium agreement" in the passage (Maria Ananicheva, Institute of Geography)	text revised and made clearer
510	51848	28	46	6	46	6	It may be beneficial to assume a more conditional framing here regarding changes in the summer sea ice. (Katharine Mach, IPCC WGII TSU)	noted
511	42895	28	46	7	0	0	Antarctic fur seal is the other species that has and will increase along the peninsula in response to climate change. Should read southern elephant seals and Antarctic fur seals are not dependent on ice. (Daniel Costa, University of California Santa Cruz)	noted in considering revisions.
512	51849	28	46	21	46	26	"likely" on lines 21 and 26 -- If this term is being used per the uncertainties guidance for authors (reflecting a probabilistic basis for its assignment), it should be italicized. Casual usage of this reserved likelihood term should be avoided. (Katharine Mach, IPCC WGII TSU)	noted
513	47138	28	46	31	46	31	Please add: "As well, new research is suggesting potential long-term impacts on growth and reproduction 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 survival of larval krill (Kawaguchi et al., 2010)." Kawaguchi et al. (2011) should be Kawaguchi et al. (2010). (Vincent Saba, NOAA National Marine Fisheries Service)	noted. will consider when published
514	45199	28	46	34	0	0	Should add a paragraph on future seabirds responses because since AR4 there were key studies on Antarctic seabirds projecting future responses by analyzing output from CMIp3. Ainley et al (2010) projected the effect of change of Antarctic penguin sea ice habitat and concluded that climate output projects a marked narrowing of penguins' zoogeographic range. Jenouvrier et al. (2009-cited, 2012: Jenouvrier, S.; Holland, M.; Stroeve, J.; Barbraud, C.; Serreze, M.; Weimerskirch, H. & Caswell, H. Effects of climate change on an emperor penguin population: analysis of coupled demographic and climate models. Global Change Biology, 2012) projected a dramatic decline of emperor penguin population in Terre Adélie by 2100, if sea ice shrinks as projected by climate models. Barbraud et al. (2011- cited) projected the responses of three seabirds in the southern ocean. (Stephanie Jenouvrier, Woods Hole Oceanographic Institution)	recent reviews have been included in text
515	35253	28	46	35	50	3	Section 28.3.3 comment: This section focuses mainly on terrestrial flora, and not terrestrial fauna. Fauna is also expected to change, both as a direct result of rising temperatures and as an indirect result of changes in flora. There are many appropriate references by Callahan et al. For example AMBIO 2011. (Ellen Øseth, Norwegian Polar Institute)	If time allows it will be done, but the literature on this is scarce
516	41973	28	46	37	0	0	Section 28.3.3.1. Impact of forest fires and changes in forest fire regime as well as impact of changes in permafrost are not even mentioned in this section (Vladimir Romanovsky, University of Alaska Fairbanks)	Cross-ref to ch 4 of WG I and of WG II
517	44702	28	46	43	0	0	the same for the section "Antarctica and the Southern Ocean" - the ecosystems are payed more attention (Maria Ananicheva, Institute of Geography)	Noted
518	51850	28	46	49	47	26	For statements in these paragraphs where appropriate, the author team should consider further specifying relevant climate/socio-economic scenarios and/or time frames. (Katharine Mach, IPCC WGII TSU)	Socio-economic scenarios not available
519	45200	28	47	43	0	0	Should appear as a separate section of other drivers (Stephanie Jenouvrier, Woods Hole Oceanographic Institution)	noted - text has been substantially revised
520	51851	28	48	2	48	9	The author team should consider assigning and presenting calibrated uncertainty language to characterize its degree of certainty in these conclusions. (Katharine Mach, IPCC WGII TSU)	noted
521	36696	28	48	16	0	0	section 28.3.3.3 - Why is there not a similar section dealing with human impacts for the Arctic (see earlier comments). This type of discussion should also be better linked to the impacts of climate change (discuss the combination of these effects. (Sharon Smith, Geological Survey of Canada)	noted - text has been substantially revised
522	51852	28	48	16	0	0	Section 28.3.3.3. For this section, the author team should ensure a focus on projections, not observations, consistent with the overall focus of 28.3. (Katharine Mach, IPCC WGII TSU)	noted - text has been substantially revised
523	43675	28	48	32	0	0	For Antarctic Treaty System add cross reference to see 28.2.7. on page 36 (Marjut Kaukolehto, University of Helsinki)	noted - text has been substantially revised
524	43676	28	48	39	0	0	For tourism add cross reference to see 28.2.6.2.2. on page 35 (Marjut Kaukolehto, University of Helsinki)	noted - text has been substantially revised
525	51853	28	48	50	0	0	Section 28.3.3.4. In the title of this section, it would be helpful to clarify the focus on Antarctica. (Katharine Mach, IPCC WGII TSU)	noted - text has been substantially revised
526	39106	28	48	50	49	13	re Introduction of invasive species, including disease agents - see Grimaldi et al 2011 Polar Record 47 (240) 56-66. (Eric Woehler, University of Tasmania)	noted - text has been substantially revised

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
527	51854	28	49	5	49	53	"likely" on lines 5, 8, 53 -- If this term is being used per the uncertainties guidance for authors (reflecting a probabilistic basis for its assignment), it should be italicized. Casual usage of this reserved likelihood term should be avoided. (Katharine Mach, IPCC WGII TSU)	noted - text has been substantially revised
528	44703	28	49	6	0	0	I think it is necessary to make more stress on the impact of tourism on the natural environment (Maria Ananicheva, Institute of Geography)	noted - text has been substantially revised
529	37298	28	49	13	49	13	Same as comment above (Alison Cook, Swansea University)	noted - text has been substantially revised
530	43677	28	50	0	0	0	28.3.5. Economic sectors: move text from 28.2.6.1.2. to this chapter to improve focus. (Marjut Kaukolehto, University of Helsinki)	This has been done.
531	51855	28	50	5	0	0	Section 28.3.4. The author team might consider merging this section with 28.3.5, reducing redundancy as well. (Katharine Mach, IPCC WGII TSU)	The two sections have been merged. It section on economic systems has been merged into the section on economic sectors.
532	41805	28	50	7	0	11	It is certainly true that non-Arctic actors are well positioned to benefit from increased shipping and and resource industries. This is also the case with the tourism sector becaue operators and tourism companies are often owed and operated by non-Arctic people. (Daniel Scott, University of Waterloo)	Noted.
533	51856	28	50	9	50	9	"likely" -- If this term is being used per the uncertainties guidance for authors (reflecting a probabilistic basis for its assignment), it should be italicized. Casual usage of this reserved likelihood term should be avoided. (Katharine Mach, IPCC WGII TSU)	Noted.
534	36697	28	50	13	50	13	Arctic communities (or indigenous communities if that is what you mean) is better terminology. (Sharon Smith, Geological Survey of Canada)	Acknowledged.
535	37602	28	50	27	0	0	No reference listed for Epstein and Ferber (Jon Rosales, St. Lawrence University)	Has been added
536	37603	28	50	29	0	0	No reference listed for SCEIGW (Jon Rosales, St. Lawrence University)	Has been added
537	35651	28	50	29	50	29	better write "Thawing tundra". "Melting" describes a physical phase change during a temperature increase when a solid substance is transformed into a liquid state. Hence, the term "melting tundra" suggests the transition of solidly frozen permafrost terrain into a liquid, cf Grosse et al. 2010 (reference in first comment above). (Ketil Isaksen, Norwegian Meteorological Institute)	Has been corrected.
538	36698	28	50	29	50	29	Please do not use the term "melting tundra" as this is incorrect terminology. The tundra is not melting but rather the frozen ground (or permafrost) may thaw and only the ice in the ground melts not the soil portion (i.e. it does not change from solid to liquid). See Grosse et al. (2010) for further discussion on correct terminology. It is the thawing of permafrost that may lead to differential movements that may have implications for performance and integrity of pipelines. Note Epstein et al (2008) did not make the statement regarding buckling of pipelines and thawing permafrost has not caused significant issues yet for pipelines in AK or northern Canada. Note that whether or not there will be these impacts, will depend on the design which may allow for these differential movements. Ref: Grosse, G., Romanovsky, V., Nelson, F.E., and Lewkowicz, A.G. 2010. Why permafrost is thawing, not melting. EOS Transactions of the American Geophysical Union, 91(9): 87. (Sharon Smith, Geological Survey of Canada)	This has been incorporated into the text.
539	41974	28	50	29	50	29	"Melting tundra" is incorrect term that came from the media but not from the scientific literature (Vladimir Romanovsky, University of Alaska Fairbanks)	Has been corrected.
540	41002	28	50	32	0	0	See comment identified as Chapter 28 pg 32 line 5 re impact the reduction in the Chinook Run on the Yukon River is having on aboriginal and commerical fisheries along the river. Potentially the most serious result will be isolated communiteis with no easy access to non country food. (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	Noted, but not included due to strict space limitations. We added some references to salmon runs.
541	41975	28	50	36	50	36	I am not sure about other communities, but Kivalina was moved to its present location relatively recently (much more recent than 4000 years ago) (Vladimir Romanovsky, University of Alaska Fairbanks)	Sentence has been removed.
542	37726	28	50	38	0	0	Comment 1: Although no one currently considers there to be a significant potential for armed conflict in the Arctic, the relationship of climate change in the Arctic to national security is a major concern of many countries, and it should not be neglected the chapter. Add(?): The increasing access to the Arctic is also producing geopolitical tensions with the potential for military responses. The Bulletin of the Atomic Scientists published a Global Forum that illustrated American, Canadian, and Russian perspectives (Huebert, 2012, Morozov, 2012, Backus, 2012). The Center for Climate and Energy Solutions produced a study portraying the Arctic as a bellwether of climate change and international security (Hubert et al., 2012). The National Academies produced a study for the U.S. Navel studies that highlighted concerns in the Arctic (Navel Studies Board, 2011). (George Backus, Sandia National Laboratories)	Dedicated CA Professor of political science Alexander Sergunin was invited to cover the theme of climate related conflicts. His contribution will be included into the final text of the chapter.
543	37727	28	50	38	0	0	Comment 2: Internationally, the Arctic represents many geopolitical challenges (Kraska, 2011). [Huebert, R., H. Exner-Pirot, A. Lajeunesse, J. Gullede (2012) "Climate change & international security: The Arctic as a Bellwether." Arlington, Virginia: Center for Climate and Energy Solutions. Available at: http://www.c2es.org/docUploads/arctic-security-report.pdf] [Huebert, R., 2012: Arctic 2030: What are the consequences of climate change(?): The Canadian response. Bulletin of the Atomic Scientists, 2012 68: 17-21, doi:10.1177/0096340212451573] (George Backus, Sandia National Laboratories)	Dedicated CA Professor of political science Alexander Sergunin was invited to cover the theme of climate related conflicts. His contribution will be included into the final text of the chapter.
544	37728	28	50	38	0	0	Comment 3: [Morozov, Y., 2012: Arctic 2030: What are the consequences of climate change(?): The Russian response. Bulletin of the Atomic Scientists, 68: 22-27, doi:10.1177/0096340212451572][Backus, G., 2012: Arctic 2030: What are the consequences of climate change(?): The US response. Bulletin of the Atomic Scientists July/August 2012 68: 9-16, doi:10.1177/0096340212451568] [Kraska, J. (ed) , 2012: Arctic Security in an Age of Climate Change Cambridge University Press, New York, NY] [Naval Studies Board (2011) National Security Implications of Climate Change for U.S. Naval Forces. Washington, D.C: National Academies Press. Available at http://www.nap.edu/catalog.php?record_id=12914b] (George Backus, Sandia National Laboratories)	Noted.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
545	51857	28	50	40	0	0	Section 28.3.5. The author team should consider specifying the focus of each subsection (Arctic versus Antarctic) in the title of each. (Katharine Mach, IPCC WGII TSU)	Has been fixed. Section title - Arctic - has been added.
546	51858	28	50	52	50	54	Given the description of evidence here, the author team may wish to consider assigning calibrated uncertainty language, especially summary terms for evidence and agreement. Additionally, given the focus of this section on projections, the author team may wish to revisit the description here of "historical links." (Katharine Mach, IPCC WGII TSU)	Noted.
547	51859	28	51	2	51	9	As available, the author team should consider providing citations in support of these criteria. (Katharine Mach, IPCC WGII TSU)	Accepted
548	41003	28	51	12	51	29	No mention of the relative size of the circumpolar boreal forest and the reality that there is likely to be increase interest in the fibre resources contained. Also the significance of the boreal forest as a carbon sink. (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	Will consider this point for the next draft.
549	37093	28	51	17	0	18	does mushrooms mean increase in eatable mushroom production or pathogenic fungi? The winter hardening especially in non-woody plants can be negatively effected by the prolonging autumn because the daylength remains the same. (Antti Hannukkala, Agrifood Research Finland)	Has been changed to read "fungal".
550	37264	28	51	18	0	0	I had to laugh at this one "illnesses and mushrooms" should be "diseases and fungal infections" (Erica Head, Fisheries and Oceans Canada)	Has been corrected.
551	41976	28	51	18	51	18	What does "increase conditions for plant illnesses and mushrooms" really mean? (Vladimir Romanovsky, University of Alaska Fairbanks)	Sentence has been changed.
552	51860	28	51	18	51	18	"likely" -- If this term is being used per the uncertainties guidance for authors (reflecting a probabilistic basis for its assignment), it should be italicized. Casual usage of this reserved likelihood term should be avoided. (Katharine Mach, IPCC WGII TSU)	Noted.
553	41977	28	51	19	51	20	What does "A warmer climate will ... increase the distance to all-year roads" mean? (Vladimir Romanovsky, University of Alaska Fairbanks)	Sentence has been edited out.
554	44704	28	51	23	0	24	supply-side, and demand-side - the term should be explained (Maria Ananicheva, Institute of Geography)	Comment unclear.
555	41978	28	51	23	51	23	Is "sanding" the right term to use here? (Vladimir Romanovsky, University of Alaska Fairbanks)	Yes it is the correct term
556	41979	28	51	25	51	25	How warmer climate can limit "storage space for wood" (Vladimir Romanovsky, University of Alaska Fairbanks)	Sentence rephrased
557	51861	28	51	27	51	28	It would be helpful to indicate more specifically the relevant time frame as well as the climate/socio-economic scenario used. Additionally, the wording on line 28 should be clarified. (Katharine Mach, IPCC WGII TSU)	Will be considered
558	36699	28	51	32	0	0	Section 28.3.5.3 - Regarding changing permafrost conditions - It is important to note that not all infrastructure will be affected by a changing climate. Structures built on ice-rich soils (particularly on shallow foundations) will be more vulnerable to thawing and a changing climate than those built on ice-poor soils or bedrock (or on deep foundations anchored in bedrock) and impacts are likely to be negligible. (Sharon Smith, Geological Survey of Canada)	This point has been included in the SOD
559	51862	28	51	44	51	54	It would be preferable to provide citations in support of these statements. (Katharine Mach, IPCC WGII TSU)	Will look for citations
560	36700	28	51	47	51	54	Parts of this paragraph should probably be rewritten with consideration to the comment above. Suggested examples - Communication towers and energy transmission infrastructure located in remote areas underlain by ice-rich permafrost may become more susceptible to permafrost thaw, increasing the risk of failure....; Energy pipelines built over ice-rich terrain may become at risk of failure due to differential movements that accompany thawing due to climate warming.; Where frozen conditions are relied on for performance and containment of mine waste containment facilities (e.g. frozen cored dams on tailing ponds, permafrost encapsulation for tailing piles), warmer conditions could affect the integrity of these structures, potentially leading to release of contaminants if contingency plans are not in place. (Sharon Smith, Geological Survey of Canada)	These examples are already included.
561	51863	28	51	49	51	49	"likely" -- If this term is being used per the uncertainties guidance for authors (reflecting a probabilistic basis for its assignment), it should be italicized. Casual usage of this reserved likelihood term should be avoided. (Katharine Mach, IPCC WGII TSU)	Acknowledged and italics removed.
562	41004	28	52	3	0	0	I was unable to find this National Roundtable report and others referred to in the text listed in the bibliography. Ensure all references referred to in the text are listed (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	Reference has been included
563	51864	28	52	12	52	20	For these statements as appropriate, the author team should consider specifying the relevant climate/socio-economic scenarios. (Katharine Mach, IPCC WGII TSU)	Considering including scenarios where possible.
564	49235	28	52	27	52	29	please integrate key findings related to this aspect into the executive summary (Oyvind Christophersen, Climate and Pollution Agency)	Not included due to strict space limitations.
565	36701	28	52	34	52	48	This section could probably be significantly reduced and likely repeats information provided earlier. (Sharon Smith, Geological Survey of Canada)	Acknowledged
566	41005	28	52	34	53	54	While not part of the USGS report somewhere there should be mention of the increasing interest in potentially accessing the methane hydrate deposits. One possible report - Council of Canadian Academies http://www.scienceadvice.ca/en/assessments/completed/gas-hydrates.aspx (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	Will consider including this.
567	37604	28	52	35	0	0	No reference listed for USGS 2008 (Jon Rosales, St. Lawrence University)	Noted
568	36702	28	52	53	52	53	It might be more correct to say "a reduction of operating period for ice roads" rather than "disappearance of ice roads". You might also say that ice roads may not be a viable operation in the future due to a reduction in operating period. (Sharon Smith, Geological Survey of Canada)	Acknowledged
569	51865	28	53	6	53	18	This paragraph is repeated from page 40. Overlap should be eliminated. (Katharine Mach, IPCC WGII TSU)	It has been removed

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
570	36703	28	53	6	53	51	All this information is probably not necessary and may repeat information provided earlier. This section could therefore be substantially reduced (especially if tables and figures provide much of the information). (Sharon Smith, Geological Survey of Canada)	Noted
571	43678	28	53	7	0	0	regarding ref Forbes, see comment on p 40 line 38. This text is also repetition with page 52 lines 34-37. (Marjut Kaukohehto, University of Helsinki)	Removed to eliminate repetition
572	37605	28	53	18	0	0	No reference listed for McCarthy et al. and Magga et al. (Jon Rosales, St. Lawrence University)	To be listed.
573	44705	28	53	22	0	0	I propose to place here a photo of damaged ice roads, there are some available for Northern Russia (Oleg Anaisimov should have) (Maria Ananicheva, Institute of Geography)	Will be considered
574	37606	28	53	24	0	0	No reference listed for Wood Mackenzie 2006 (Jon Rosales, St. Lawrence University)	To be listed.
575	49236	28	53	25	53	26	please integrate key findings related to this aspect into the executive summary (Oyvind Christophersen, Climate and Pollution Agency)	To be considered, but space limitations.
576	44706	28	53	26	0	38	Interesting practical information in the Proceedings of the Twenty-first (2011) International Offshore and Polar Engineering Conference Maui, Hawaii, USA, June 19-24, 2011 -The Challenges of Deep Water Arctic Development, Jed M. Hamilton, Offshore Function, ExxonMobil Upstream Research Company, Houston, Texas, USA (Maria Ananicheva, Institute of Geography)	Noted
577	54026	28	53	45	0	0	"In Arctic Russia the extraction of energy alone contributes close to 60 per cent of regional GDP (see Figure 28-8)." I could not obtain the information stated above from Figure 28-8. If I look at the data as it is presented, I would interpret that Arctic Russia alone to consist of close to 100% of the regional gas production up to year 2000 and then projected to decline a little, but cannot see any reference to the total energy extraction or regional GDP from the figure. (Yuka Estrada, IPCC WGII TSU)	Will be fixed in updated graphic
578	44707	28	54	3	0	10	I think the Figure - Map of the Arctic Ocean showing the mean winter distribution of ice thickness in 2007 (min) is need to place here (Maria Ananicheva, Institute of Geography)	Acknowledged
579	41006	28	54	15	54	20	The three active proposals for arctic submarine fibre optic cables connecting eastern Asia with Europe - one through the NSR and two through the NWP and all planned to be in operation before 2015 illustrate the non shipping uses for sea routes that are being made possible by seasonal ice free periods and which will require at least periodic access for maintenance. http://www.extremetech.com/extreme/122989-1-5-billion-the-cost-of-cutting-london-toyko-latency-by-60ms (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	Has been included in section
580	36704	28	54	23	0	0	Section 28.4 - There are a number of Canadian examples that could be given to demonstrate advances with respect to adaptation. The Nunavut Climate Change Partnership (see Mate & Reinhart 2011) which had a focus on community adaptation (and included collaboration with Canadian Institute of Planners). Related to this was establishment of permafrost monitoring sites in communities, which is mentioned in ch 26 (Ednie and Smith 2010, 2011) and terrain sensitivity mapping (e.g. Leblanc et al. 2010). A more recent effort is the Regional Adaptation Collaboratives (for one related to Nunavut see: http://www.climatechangenunavut.ca/en/project/nunavut-regional-adaptation-collaborative). Other specific examples given below. Relevant Refs: Mate DJ and Reinhart, F (ed.) 2011. Nunavut climate change partnership workshop, Feb 15-16 2011. Geological Survey of Canada Open File 6867 http://geoscan.ess.nrcan.gc.ca/cgi-bin/starfinder/0?path=geoscan.fl&id=fastlink&pass=&format=FLSHORTORG&search=R=288645 ; Ednie, M., and Smith, S.L. 2010. Establishment of community-based permafrost monitoring sites, Baffin region, Nunavut. In GEO2010, 63rd Canadian Geotechnical Conference & 6th Canadian Permafrost Conference Calgary. GEO2010 Calgary Organizing Committee, pp. 1205-1211. http://www.aina.ucalgary.ca/scripts/minisa.dll/1039/1/0?SEARCH Ednie, M., and Smith, S.L. 2011. Establishment of community-based permafrost monitoring sites and initial ground thermal data Baffin Region, Nunavut, Geological Survey of Canada Open File 6727. http://geoscan.ess.nrcan.gc.ca/cgi-bin/starfinder/0?path=geoscan.fl&id=fastlink&pass=&format=FLSHORTORG&search=R=287873 Leblanc, A.-M., Oldenborger, G., Sladen, W., Mate, D., Carbonneau, A.-S., Gosselin, P., L'Hérault, E., and Allard, M. 2010. Assessing permafrost conditions in support of climate change adaptation in Pangnirtung, Nunavut. In GEO2010, 63rd Canadian Geotechnical Conference & 6th Canadian Permafrost Conference Calgary, Sept. 2010. GEO2010 Calgary Organizing Committee, pp. 1242-1250. http://www.aina.ucalgary.ca/scripts/minisa.dll/1039/1/0?SEARCH (Sharon Smith, Geological Survey of Canada)	Additional references noted.
581	51866	28	54	31	54	31	"likely" -- If this term is being used per the uncertainties guidance for authors (reflecting a probabilistic basis for its assignment), it should be italicized. Casual usage of this reserved likelihood term should be avoided. (Katharine Mach, IPCC WGII TSU)	Noted
582	49237	28	54	34	54	35	please integrate key findings related to this aspect into the executive summary (Oyvind Christophersen, Climate and Pollution Agency)	Task for author team.
583	44708	28	54	44	0	0	The rapid shrinkage of summer ice extent in recent years is one of the most prominent expressions of Arctic and global climate change - it is important to stress on. (Maria Ananicheva, Institute of Geography)	Comment seems to be misplaced however sense will be incorporated in appropriate place
584	37607	28	55	1	0	0	A note on style: omit reference to Nordhouse and all direct quotes. No scholar should take precedence by being quoted directly. (Jon Rosales, St. Lawrence University)	Need advice
585	49238	28	55	1	55	5	please integrate key findings related to this aspect into the executive summary (Oyvind Christophersen, Climate and Pollution Agency)	Noted
586	44709	28	55	6	0	0	Besides Antarctic and Greenland ice sheet: Mountain glaciers and ice caps in the Arctic cover an area of around 402 000 km2 and contain about 0.41 m sea-level equivalent of water. (SWIPA) (Maria Ananicheva, Institute of Geography)	Comment seems to be misplaced however sense will be incorporated in appropriate place
587	35652	28	55	8	55	8	write "thawing permafrost", cf previous comments (Ketil Isaksen, Norwegian Meteorological Institute)	Noted

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
588	41980	28	55	8	55	8	Should be "thawing permafrost" instead of "melting permafrost" (Vladimir Romanovsky, University of Alaska Fairbanks)	Noted
589	44710	28	55	9	0	0	Sea-level rise threatens first of all to cover (to flood) low-situated towns and even cities such as Sankt-Peterburg, Datch cities, etc (Maria Ananicheva, Institute of Geography)	Comment seems to be misplaced however sense will be incorporated in appropriate place
590	44711	28	55	10	0	0	Melting of mountain glaciers causes deterioration of drinking water supply for mountain communities (e.x. Polar and Subpolar Ural, industrially damaged region) (Maria Ananicheva, Institute of Geography)	Comment seems to be misplaced however sense will be incorporated in appropriate place
591	41007	28	55	10	55	12	No problem with the statement but throughout the report there is little recognition for travel in non marine areas- on rivers and lakes (frozen and unfrozen) and across the land. (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	Noted
592	43679	28	55	25	55	26	"...general lack of national policies on adaptations as is illustrated by the Nordic countries.." this is confusing statement and I cannot check it because the reference is not in the reference list. However Finland is one of the leading countries in adaptation policies, how is the status with Russia for example? Why do you take Nordic countries as an example in this matter? (Marjut Kaukoletto, University of Helsinki)	This comment will be discussed with other authrs and rewritten to be more balanced.
593	49239	28	55	38	55	46	please integrate key findings related to this aspect into the executive summary (Oyvind Christophersen, Climate and Pollution Agency)	Noted
594	41008	28	56	7	0	0	in government, service industries such as education and health, tourism, and commercial enterpses etc. As a later statement says education is increasingly critical. (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	Comment seems to be misplaced however sense will be incorporated in appropriate place
595	37608	28	56	18	0	0	Not only forced migration has had deep cultural impacts, voluntary relocation has as well as in the case of the King Island community in Western Alaska who relocated in the 1950s. (Jon Rosales, St. Lawrence University)	Accepted
596	44712	28	56	18	0	0	We conducted the zoning of mountain regions of Russia by the a number of indicators (including weather variability) and have got the map of degree of comfort of human life (published in Russian with English summary) V. V. Vinogradova, M. D. Ananicheva Arctic mountain regions' zoning according to human life conditions in European part and North-east of Russia In: Problems of environmental monitoring and projection of ecosystems. Vol. XXIII, Moscow. Institute of global climate and ecology, p.194-215. (Maria Ananicheva, Institute of Geography)	Comment seems to be misplaced but we will try to incorporate this information as appropriate.
597	44713	28	56	22	0	44	Health impacts section has much common with that of in the first part of the Draft, IMHO (Maria Ananicheva, Institute of Geography)	IMHO report still a draft but comment seems to be a positive reflection on our text.
598	41009	28	56	26	0	0	SAR- Synthetic Aperature Radar? Obviously the output is used by some communities but the technology is based with Space Agencies (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	Noted
599	41010	28	56	53	0	0	two way communications and interpretation of information are critical to success. (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	Agreed
600	41011	28	57	20	0	0	I see no recognition of the amazing adaptaions that have been incorporated into Research Bases and operations in the Antarctic - technologies that often could be applied in both the Arctic and also in some alpine situations. Often these are in response to the need to improve sustainability and security, to demonstrate a technology, and to lessen operational costs for specific financial line items such as energy. Examples include the use of Sterling Engines by New Zealand and others ; use of wind turbines to generate electricity and produce hydrogen that is then used as a fuel (Australia), solar and geothermal energy at Prncess Elizabeth which is energy self sufficeint (Belgium), Moveable stuctures so stations can remain geo stationary and respond to loss of ice shelves (Hadley VI UK), Greenhouses (Hadley), Transportation technologies , waste containment and removal etc.. Also challenges in providing heath services and responding to the introduction of new diseases with tourism, Search and Rescue etc. (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	Some interesting ideas, to be discussed with Antarctic authors.
601	36705	28	57	23	0	0	Section 28.4.2 - There are a number of examples that can be provided from Canada that are relevant to adaptation, specifically infrastructure. These include development of guidelines etc. that can assist practitioners, communities, decision makers and are advances of the Environment Canada (1998) document that has been cited. These include guideline documents developed by the Canadian Standards Association (CSA) and Transportation Association of Canada (TAC). These are the type of things that should be included in this assessment not just general statements regarding adaptation techniques etc. Refs: Canadian Standards Association (2010) Technical Guide - Infrastructure in permafrost: a guideline for climate change adaptation. CSA Special Publication Plus 4011-10. Transportation Association of Canada (2010) Guidelines for development and management of transportation infrastructure in permafrost regions. May 2010 TAC, Ottawa (Sharon Smith, Geological Survey of Canada)	Additional references noted
602	36706	28	57	23	0	0	section 28.4.2 - There have been efforts to in Canada to assess the vulnerability of the northern mining sector and develop best practices and there are specific examples for Nunavut including reports available on the Nunavut Adaptation Collaborative web site (http://www.climatechangenunavut.ca/en/project/nunavut-regional-adaptation-collaborative) - Note this is mentioned in Ch 26 and should be mentioned here. The relevant reports are: Golder (2012) Vulnerability Assessment of the Mining Sector to Climate Change Task 1 Report. Prepared for Nunavut Regional Adaptation Collaborative. AND Golder (2012) Good Environmental Practices for Northern Mining and Necessary Infrastructure Task 2 Report. Prepared for Nunavut Regional Adaptation Collaborative. (Sharon Smith, Geological Survey of Canada)	Duplicate comment
603	36707	28	57	23	0	0	Section 28.4.2 - Also relevant to climate change adaptation of the Canadian mining sector are reports produced by Mine Environmental Neutral Drainage (MEND) Program that are available at http://www.mend-nedem.org . These include a general report on climate change risks to mining (MEND 1.61.7 - ref. provided earlier) that does include references to northern mines. Others that are relevant are associated with cover design for northern mine waste disposal facilities and include MEND 1.61.4, 1.61.5a, 1.61.5b. (Sharon Smith, Geological Survey of Canada)	Additional references noted.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
604	36708	28	57	23	0	0	Section 28.4.2 - For the transportation sector, efforts at advancing adaptation in Canada include establishment of test sites to evaluate various techniques. One example is the Beaver Creek Yukon Test Site on the Alaska Highway. Information on this project can be found in Lepage and Dore (2010). Ref: Lepage, J.M., and Dore, G. 2010. Experimentation of mitigation techniques to reduce the effects of permafrost degradation on transportation infrastructures at Beaver Creek experimental road site (Alaska Highway, Yukon). In GEO2010, 63rd Canadian Geotechnical Conference & 6th Canadian Permafrost Conference Calgary. GEO2010 Calgary Organizing Committee, pp. 526-533. http://136.159.147.171/scripts/minisa.dll/5028/1/0?SEARCH (Sharon Smith, Geological Survey of Canada)	Noted
605	51867	28	57	27	57	31	The author team should provide citations in support of the statements as appropriate. Additionally, if "likely" on line 30 is being used per the uncertainties guidance for authors (reflecting a probabilistic basis for its assignment), it should be italicized; casual usage of this reserved likelihood term should be avoided. (Katharine Mach, IPCC WGII TSU)	Noted
606	36709	28	57	36	57	36	Prowse et al (2009, already cited in text) can probably be substituted for Dyke (2001). A reference for Dyke (2001) is not provided but it is likely a reference specific to sumps and not general enough given that the paragraph discusses many aspects of resource development. (Sharon Smith, Geological Survey of Canada)	Agreed
607	41012	28	57	38	0	0	NO mention of the emerging application of hybrid lighter than air vehicles to provide heavy lift capacity while minimizing the need for extensive runways and avoiding the need for surface transport such as roads and ice roads- http://www.discoveryair.com/page?a=563&lang=en-CA and http://www.hybridairvehicles.com (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	Noted but is the reference peer reviewed?
608	36710	28	57	40	57	49	Hayley and Horne (2008) provides a demonstration of how the screening tool has been implemented. Ref Hayley, D.W., and Horne, B. 2008. Rationalizing climate change for design of structures on permafrost : a Canadian perspective. In Proceedings of Ninth International Conference on Permafrost. Edited by D.L. Kane and K.M. Hinkel. Fairbanks. Institute for Northern Engineering, University of Alaska Fairbanks, Vol.1, pp. 681-686. (Sharon Smith, Geological Survey of Canada)	Noted
609	41013	28	57	41	57	42	The reference referred to as Environment Canada (1998): Climate change impacts on permafrost engineering design; Environment Canada, Environmental Adaptation Research Group. This report is often referred to as the PERD report - PERD really being a larger program - "Program of Energy Research and Development" and has a large number of publications published under its umbrella. I am not aware of this specific report being posted on the web. Again there is no reference to it in the reference section. The sentence used in the text comes from the Northern Chapter of NRCan's From Impacts to Adaptation: Canada in a Changing Climate 2007 http://www.nrcan.gc.ca/earth-sciences/climate-change/community-adaptation/assessments/749 . The more complete guidance was developed by the The Federal-Provincial-Territorial Committee on Climate Change and Environmental Assessment published by CEAA November 2003 Incorporating Climate Change Considerations in Environmental Assessment: General Guidance for Practitioners http://www.ceaa.gc.ca/default.asp?lang=En&n=A41F45C5-1&offset=&toc=hide There is another report published in 2000 that could be considered an early attempt to incorporate some aspects of Climate Change into EA http://books.google.ca/books?id=DS_omi1pyMYC&pg=PA9&lpg=PA9&dq=Climate+change+impacts+on+permafrost+engineering+design;+Environment+Canada,+Environmental+Adaptation+Research+Group&source=bl&ots=e_eggVe5Z&sig=Y1H0jzVGG37dUzHsV_qLkyGJMyo&hl=en&sa=X&ei=n3EVUO_fPMTUqgHui4CgDA&ved=0CE8Q6AEwAQ#v=onepage&q=Climate%20change%20impacts%20on%20permafrost%20engineering%20design%3B%20Environment%20Canada%2C%20Environmental%20Adaptation%20Research%20Group&f=false (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	A useful up-date, will be reflected in the redraft of this section.
610	36711	28	57	51	58	8	The updated SWIPA permafrost chapter should be utilized as a reference here and the paragraph should be updated as required (Instanes et al 2005 is from ACIA). Couture et al. (2003) can also be removed as the SWIPA permafrost chapter and also the CSA document (ref provided in earlier comment) provide updated information regarding construction techniques etc. With respect to mining development the Golder (2012) Task 2 rept on development of best practices (see previous comments for full citation) also provides a summary of potential adaptation techniques. (Sharon Smith, Geological Survey of Canada)	A useful up-date, will be reflected in the redraft of this section.
611	41014	28	57	51	58	8	Guidance materials are now available to assist community managers , developers and professions in incorporating climate change into the design of some infrastructure- examples CSA http://shop.csa.ca/en/canada/infrastructure-and-public-works/plus-4011-1st-ed-pub-2010/inv/27030762010/ . Transportation Association of Canada have sponsored a number of pieces of work examples Permafrost http://www.tac-atc.ca/english/resourcecentre/readingroom/pdf/primers/permafrost.pdf and Ice roads http://www.tac-atc.ca/english/resourcecentre/readingroom/conference/conf2008/docs/a1/mcgregor.pdf (next paragraph) (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	Noted, reinforces other comments.

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612	36715	28	58	2	58	3	References could be provided for recent work done to investigate or test the effectiveness of air convection embankments for both transportation and mine waste rock pile design (to ensure permafrost encapsulation). Examples include Arenson et al. (2007), Pham et al. (2008), Lepage & Dore (2010), Jorgensen et al (2008). Ficheur & Dore (2010). Refs: Jorgensen, AS, Dore, G. et al. (2008) Assessment of the effectiveness of two heat removal techniques for permafrost protection. Cold Regions Sci & Tech, 53:179-192.; Arenson, L.U., Pham, H.-N., Klassen, R., and Sego, D.C. 2007. Heat convection in coarse waste rock piles. In Ottawa Geo2007 - 60th Canadian Geotechnical Conference. Ottawa. Canadian Geotechnical Society, pp. 1500-1507; Pham, H.-N., Sego, D.C., Arenson, L.U., Blowes, D., and Smith, L. 2008. Convective heat transfer and waste rock piles under permafrost environment. In GeoEdmonton 08 - 61st Canadian Geotechnical Conference. Edmonton. Canadian Geotechnical Society, pp. 940-947; Ficheur, A and Dore, G. 2010 Expérimentations de techniques de mitigation des effets de la fonte du pergélisol sur les infrastructures du Nunavik : aéroport de Tasiujaq. In GEO2010, 63rd Canadian Geotechnical Conference & 6th Canadian Permafrost Conference Calgary. GEO2010 Calgary Organizing Committee, p. 485-492 http://www.aina.ucalgary.ca/scripts/minisa.dll/1304/1/0?SEARCH ; Lepage, J.M., and Dore, G. 2010. Experimentation of mitigation techniques to reduce the effects of permafrost degradation on transportation infrastructures at Beaver Creek experimental road site (Alaska Highway, Yukon). In GEO2010, 63rd Canadian Geotechnical Conference & 6th Canadian Permafrost Conference Calgary. GEO2010 Calgary Organizing Committee, pp. 526-533. http://136.159.147.171/scripts/minisa.dll/5028/1/0?SEARCH (Sharon Smith, Geological Survey of Canada)	Useful references
613	36712	28	58	6	58	8	The importance of monitoring program to monitor infrastructure performance and environmental effects has been outlined by Burgess et al. (2010). Additional recommendations regarding monitoring for mining developments are found in Golder (2012) Task 2 report on best practices (ref in previous comments). Ref: Burgess, M.M., Oswell, J., and Smith, S.L. 2010. Government-industry collaborative monitoring of a pipeline in permafrost – the Norman Wells Pipeline experience, Canada. In GEO2010, 63rd Canadian Geotechnical Conference and the 6th Canadian Permafrost Conference. Calgary, Sept 2010. GEO2010 Calgary Organizing Committee, pp. 579-586. http://136.159.147.171/scripts/minisa.dll/5028/4/1/72659?RECORD (Sharon Smith, Geological Survey of Canada)	Useful references
614	44714	28	58	13	0	0	The obstacle will be more icebergs which are produced by ice sheets and ice caps, more warm conditions facilitate dynamic ablation, i.e. iceberg calving and their wider extent throughout Polar regions (Maria Ananicheva, Institute of Geography)	Comment seems to be misplaced.
615	41015	28	58	26	0	0	See earlier comment on lighter than air heavy lift systems- http://www.discoveryair.com/page?a=563&lang=en-CA utilizing Hybrid Air Vehicles (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	Noted
616	49240	28	58	28	58	31	A reference to SRREN could be appropriate here. We propose that you consider this aspect for the executive summary. (Oyvind Christophersen, Climate and Pollution Agency)	We will consider where the IPCC/SRREN is most relevant.
617	36713	28	58	31	58	32	You need to be more specific about where there is a significant dependence on hydro-power (northern Quebec, Labrador only?) as many communities in the 3 territories are dependent on diesel. (Sharon Smith, Geological Survey of Canada)	Need to check.
618	36714	28	58	33	58	36	We need to be aware, that this type of energy source is not without its issues with respect to environmental effects. (Sharon Smith, Geological Survey of Canada)	Noted and will be discussed.
619	51868	28	58	35	58	46	"likely" on lines 35, 44, 46 -- If this term is being used per the uncertainties guidance for authors (reflecting a probabilistic basis for its assignment), it should be italicized. Casual usage of this reserved likelihood term should be avoided. (Katharine Mach, IPCC WGII TSU)	Noted
620	49241	28	58	49	59	2	please integrate key findings related to this aspect into the executive summary (Oyvind Christophersen, Climate and Pollution Agency)	Noted
621	43680	28	59	0	0	0	28.5. I would add in the gaps list the need for continuous, long term research data series and easy access to data for researchers. Without long term data series we are not able to find, confirm and test the trends. With long term data we can start to better understand the processes as well. (Marjut Kaukolehto, University of Helsinki)	Scientific, interdisciplinary, multicultural research, observation, and monitoring programs for all Arctic communities to develop the long-term knowledge base to enable quantitative assessments of impacts from climate, long-term trends, and the development of local adaptation strategies to climate changes based upon both science and traditional knowledge
622	36716	28	59	5	0	0	Section 28.5 - There was a real effort during IPY to fill data gaps but there has been no mention of that in this chapter. Commentary on remaining gaps should consider the advances that were made since TAR and ACIA to address data gaps. In addition, an effort was made during IPY to increase data availability and accessibility so that it could be utilized by practioners, decision makers, modellers etc. to better assess impacts and develop adaptation strategies. (Sharon Smith, Geological Survey of Canada)	Noted

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
623	44715	28	59	5	0	0	I don't like the phrase: The Arctic is now home to some [Reference – see AHDR] residents. (Maria Ananicheva, Institute of Geography)	Programs for strengthening and organizing long-term continuous local/regional, community-based monitoring, data collection and assessment systems for climate and other relevant changes which are linked to a national monitoring system, which include science and indigenous peoples traditional ecological knowledge. (e.g., LEO, the Local Observer Network and SAON, The Sustaining Arctic Observing Networks). Enhance and build partnerships and systems for observing weather systems across remote areas to gather accurate weather data from individual rural and indigenous communities to provide improved estimates of the patterns, magnitudes, and rates of climate changes projected for communities across the Arctic – especially for remote villages and rural locations. Increased education, capacity-building, and training for climate change science, assessment & adaptation planning for young scientists, local and indigenous Arctic residents and youth.
624	41016	28	59	5	59	33	Need for educational and research infrastructure in polar regions and the long term maintenance and operation of a coordinated monitoring networks at not just national but also international scales (example SCAN Net, SAON, PANTOS, CBMP) and linkage of these to both community based monitoring but also global networks such as GEOS, WMO networks. Better collaboration and data sharing between private sector players such as resource industries and the larger science community including sharing of data. Development of future polar (and alpine and other cold region) scientists and training northerners in science to become full time participants. Development and deployment of better forecasting systems providing output at a higher resolution including weather forecasts and regional climate scenarios. Somewhere it might be worth mentioning the contribution of the IPY 2007-08 and its contributions not only to the development of new knowledge but also many of the other objectives. Also the contribution of the overall IPY Program over 130 years and the principles of coordinated collaborative science first proposed by the initiator of the IPY concept, Karl Weyprecht, http://www.arctic.noaa.gov/aro/ipy-1/History.htm (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	A continuing process for assessing climate change impacts on public health and well-being that identifies climate-health vulnerabilities and develops/implements response capacity at the local and regional level on an ongoing basis - use ANTHC (AK Native Tribal Health Consortium) as a working model. Research is needed immediately to investigate the complicated issue of relocation of entire settlements or villages due to the impacts of climate change –solutions which are appropriate to the culture and life ways of residents - including legal, organizational, institutional, and technical aspects - to respond to permafrost thaw, sea level rise and other climate forcing factors.
625	48000	28	59	5	59	33	I am happy to see this chapter ending with a Research and Data Gaps section. I think, however, that this section is a bit limited, and doesn't cover some of the key areas that were so eloquently mentioned throughout this chapter, such as health and well-being, adaptation strategies, etc. While the natural science is of great importance, so is the social and health science aspects of climate change in the North, and its important to mention the research gaps in these areas as well, especially in your concluding paragraph. I would also suggest tha the authors try to pick up on more of the themes discussed in the chapter and really flesh out this last part to include a stronger summary and overview, as well as a more detailed directions for the future. But overall, this is a strong chapter, and very well done. (Ashlee Cunsolo Willox, McGill University)	Noted
626	49242	28	59	5	59	33	This section should in our opinion try to prioritise the data gaps and research needs that are highlighted and or justified in chapter 28 as a whole. Monitoring needs seem to have been left out, while it is stated, e.g. p.8, 116-17, insufficient spatial coverage of precipitation stations, and we understand that there are also other important monitoring needs. On page 17, line 5-6 it is stated that long-term changes in the krill population will require standardized methods etc.. Please rewrite this important sub chapter with the view to provide a prioritized list of concrete data gaps and research which needs to be filled in order to make progress in the understanding of the Polar region. (Oyvind Christophersen, Climate and Pollution Agency)	Noted
627	52654	28	59	5	59	33	Very positive with a section on research and data gaps, however little focus on such gaps in biological systems (Else Marie Løbersli, Norwegian directorate for nature management)	Noted.
628	35259	28	59	5	59	34	Section 28.5 comment: We would like to make a comment made regarding the lack of established monitoring programmes in the Arctic. Major resources are needed to study climate change impacts on endemic Arctic fauna. Without stable monitoring programmes the detection of changes relies entirely on short-time-financed projects, and the potential for not detecting changes is hence large. A suggested formulation on this is: "Arctic monitoring programmes are currently under-developed and under-financed. Major resource input is required at this time to study the impacts of climate change on endemic fauna – particularly sea-ice dependent species." (Ellen Øseth, Norwegian Polar Institute)	Noted
629	42896	28	59	28	0	0	Add this reference: Murphy, E. J., Cavanagh, R. D., Hofmann, E. E., Hill, S. L., Constable, A. J., Costa, D. P., Pinkerton, M. H., Johnston, N. M., Trathan, P. N., Klinck, J. M., Wolf-Gladrow, D. A., Daly, K. L., Maury, O. & Doney, S. C. 2012 Developing integrated models of Southern Ocean food webs: Including ecological complexity, accounting for uncertainty and the importance of scale. <i>Progress in Oceanography</i> 102, 74-92. (Daniel Costa, University of California Santa Cruz)	Acknowledged. The chapter refers to the papers that support specific statements in the text. IPCC is different from the literature review, which is why not all available publications are listed.
630	42897	28	59	30	0	0	Add Costa et al 2010 to the Trathan et al 2010 reference, they both provide suggestions on how to study climate change (Daniel Costa, University of California Santa Cruz)	Acknowledged. The chapter refers to the papers that support specific statements in the text. IPCC is different from the literature review, which is why not all available publications are listed.

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
631	42898	28	59	33	0	0	Add reference to SOOS Southern Ocean Observing System; Rintoul, S. R., Sparrow, M., Meredith, M. P., Wadley, V., Speer, K., Hofmann, E., Summerhayes, C., Urban, E. & Bellerby, R. 2012 THE SOUTHERN OCEAN OBSERVING SYSTEM: Initial Science and Implementation Strategy, pp. 75. www.soos.aq (Daniel Costa, University of California Santa Cruz)	Acknowledged. The chapter refers to the papers that support specific statements in the text. IPCC is different from the literature review, which is why not all available publications are listed.
632	44716	28	59	35	0	0	The political factor for Russia indigenous peoples is well (but in brief) described by Kathrin Wessendorf in http://www.iwgia.org/iwgia_files_publications_files/Russia_book_introduction.pdf (Maria Ananicheva, Institute of Geography)	This is not a legal reference for IPCC
633	41017	28	59	36	0	0	Though alluded to in the immediately preceding section, the role impacts in polar regions will have on global systems and vice versa. (Ian Church, Canadian Foundation for Climate and Atmospheric Science/ IPY Canada)	This is mostly WG1 domain.
634	51869	28	59	36	0	0	Frequently Asked Questions -- By the 2nd-order draft, the author team should ensure full questions and answers in this section, as it constitutes an important component of the chapter required by the plenary approved outline. (Katharine Mach, IPCC WGII TSU)	done
635	36717	28	59	44	0	0	References - There are several publications cited in the text that do not appear in the reference list. It therefore makes it difficult for reviewers to check these articles and determine whether the interpretations and conclusions etc. presented in the text are correct. (Sharon Smith, Geological Survey of Canada)	noted
636	44717	28	60	1	0	0	Health considerations - is not very good title (Maria Ananicheva, Institute of Geography)	noted
637	44718	28	60	3	0	39	Health conditions are given ONLY for Canada, no examples from other Arctic countries (Maria Ananicheva, Institute of Geography)	noted
638	44719	28	61	20	0	0	imperative (National Roundtable on the Environment and the Economy, 2009) - is it the reference which is appropriate for IPCC? (Maria Ananicheva, Institute of Geography)	No
639	44720	28	61	33	0	0	"A hunter who cannot make right judgement about what to hunt and where, cannot stay a hunter for long" - is not perfectly clear for me (Maria Ananicheva, Institute of Geography)	Noted
640	37299	28	64	31	64	31	Change reference as above (Alison Cook, Swansea University)	Unclear
641	47197	28	77	38	77	40	Now peer-reviewed and published as: Nakashima, D.J., Galloway McLean, K., Thulstrup, H.D., Ramos Castillo, A. and Rubis, J.T. 2012. Weathering Uncertainty: Traditional Knowledge for Climate Change Assessment and Adaptation. Paris, UNESCO, and Darwin, UNU, 120 pp. (Douglas Nakashima, UNESCO)	Noted
642	45201	28	89	0	0	0	Figures/ Tables: Most figures refer to the Arctic; it would be more balanced if some tables/ figures for the Antarctic section are included. I really like the table of Chapter 25 (e.g. Table 25-1). I think it would be very useful to have such table for all regional chapters. (Stephanie Jenouvrier, Woods Hole Oceanographic Institution)	Noted
643	51870	28	89	0	0	0	Tables 28-1 and 28-2. The source of data presented here should be clarified in the table captions. Additionally, relevant climate/socio-economic scenarios used for the 2050 projections should be specified. (Katharine Mach, IPCC WGII TSU)	Noted. Updated tables are being sought, and change of captions will be included.
644	54022	28	89	0	0	0	Table 28-1 and 2: The data provided in these tables may be more effective to be presented as figures. (Yuka Estrada, IPCC WGII TSU)	Noted. Will consider this option, but also issue of space limitation
645	35413	28	90	0	0	0	Peter Fretwell and I have the original Coreldraw files for this figure, and could supply them, or even undertake changes required. (David Vaughan, British Antarctic Survey)	Acknowledged. Will consider at the final preparation stage.
646	43681	28	90	0	0	0	Figure 28-1 Could add in the map also places/locations and marine sector names for Antarctica used in the text. (Marjut Kaukolehto, University of Helsinki)	Noted
647	49243	28	90	0	0	0	Fig 28-1: Show clearly on the figure where polar regions are according to this chapter. (Oyvind Christophersen, Climate and Pollution Agency)	Noted. As stated in the text, the boundaries are defined loosely.
648	43682	28	91	0	0	0	Figure 28-2 Please indicate in the caption what is study period (two years, five of ten?). Red dots are statistically significant and blue dots are not... vague expression, would it be possible to show the confidence levels more precisely? (Marjut Kaukolehto, University of Helsinki)	Noted
649	51871	28	91	0	0	0	Figure 28-2. For part a, it would be preferable to zoom in further in the map presented. For part B, for an unfamiliar reader if it would be helpful to indicate how the X axis should be interpreted (negative numbers represent an event occurring earlier in the year?). (Katharine Mach, IPCC WGII TSU)	Noted
650	54023	28	91	0	0	0	Figure 28-2: Map of the study area could be deleted as the main focus should be on the data presented at the bottom. (Yuka Estrada, IPCC WGII TSU)	Noted
651	35414	28	92	0	0	0	Fig 28-4 is a very strange figure. I'd recommend deletion. It's insufficiently explained in the caption. "relative possibility/position/ of very hard snow layers"? I don't understand it. But also, I don't see why the figure is included, is it supposed to be a strong indication of changing snow conditions? (A cursory examination suggests there are rather minor changes). And one would have to be cautious about interpreting such data it without some understanding of the general densification. I would expect to see fewer exceptionally dense layers at depth, because most of the ice is getting denser and the contrasts are being removed. (David Vaughan, British Antarctic Survey)	Noted
652	43683	28	92	0	0	0	Figure 28-3 add explanatory word in the caption, now it reads "Trends for (a, right) summer (May-August) open water and annual MaxNDVI." What open water? Open water period? Open water extent? (Marjut Kaukolehto, University of Helsinki)	Noted
653	49244	28	92	0	0	0	Fig 28-3: This figure is interesting and gives potentially a lot of information, but more explanation is needed to a lay reader. Add a and b over the figures, or delete a and b in the caption. (Oyvind Christophersen, Climate and Pollution Agency)	Noted
654	49245	28	92	0	0	0	Fig 28-4: Figure and y-axis text is difficult to grasp (Oyvind Christophersen, Climate and Pollution Agency)	Noted
655	54024	28	92	0	0	0	Figure 28-3: It is a little confusing to have the same colors (shades of purple) used for Open water and MaxNDVI on the left. (Yuka Estrada, IPCC WGII TSU)	Noted

#	ID	Ch	From Page	From Line	To Page	To Line	Comment	Response
656	54025	28	92	0	0	0	Figure 28-4: It would be useful to have further explanation on how to read and interpret this chart for readers who are generally not familiar with snow stratigraphy. What are the blue dot lines representing? (Yuka Estrada, IPCC WGII TSU)	Noted
657	49246	28	93	0	0	0	Fig 28-5: Please add for what year the activity is taking place, and consider to change colour of land masses to increase readability. (Oyvind Christophersen, Climate and Pollution Agency)	Noted
658	51872	28	93	0	0	0	Figure 28-5. For this figure, it would be helpful to specify the relevant timeframe. Additionally, do the fishing vessel days per ecosystem represent the average value each year? (Katharine Mach, IPCC WGII TSU)	Noted
659	49247	28	93	0	97	0	Fig 28-5 to Fig 28-9: Five of nine figures in total are devoted to highlight values already explored or potential for future exploration in the Arctic. While we agree that this is an important aspect, we miss at least one figure from the Antarctica on important issues there, and also the impact of changes in the polar regions on humans and animals would be appreciated. The y-axis on Fig 28-9 needs to be translated. (Oyvind Christophersen, Climate and Pollution Agency)	Noted
660	43684	28	94	0	0	0	Figure 28-6 caption: Open the acronym NGL (Marjut Kaukolehto, University of Helsinki)	The acronym NGL refers to Natural Gas Liquids. Will add this to acronym section
661	51873	28	95	0	0	0	Figure 28-7. It would be beneficial to clarify what is meant by "value added" and how it is quantified. (Katharine Mach, IPCC WGII TSU)	Value-added explanation can be added in updated figure
662	51874	28	96	0	0	0	Figure 28-8. For an unfamiliar reader, it would be helpful to clarify further what "Mtoe" stands for. (Katharine Mach, IPCC WGII TSU)	Acronym explanation will be added
663	54027	28	96	0	0	0	Figure 28-8: It must have a clear indication that this data consists of (at least partially) projected information. Also, for the purpose of the section, I do not see much value added to have a detailed regional distribution. (Yuka Estrada, IPCC WGII TSU)	Reviewer comment acknowledged. Information on projection will be requested in an edited figure.
664	51875	28	97	0	0	0	Figure 28-9. For the y-axis, an English translation should be provided. Additionally, it would be helpful to clarify why the different series have differing time frames. (Katharine Mach, IPCC WGII TSU)	Acknowledged. A translation will be added in an edited figure.
665	54028	28	97	0	0	0	Figure 28-9: The y-axis label must be provided in English. A further explanation must be provided to communicate this figure better (e.g. why is the data for NW passage available only to a little over year 2000 if this is a projected data? What is the shaded area indicating?) (Yuka Estrada, IPCC WGII TSU)	Acknowledged. A translation will be added in an edited figure.