



WP **12**
Agenda Item: 2.2.3
Person Responsible: J Gutt

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Antarctic Thresholds - Ecosystem Resilience and Adaptation (AnT-ERA)

Executive Summary

Title: Antarctic Thresholds - Ecosystem Resilience and Adaptation (AnT-ERA)

Authors: J. Gutt

Introduction/ Background: The successful preparatory phase of the program in 2013 provided a basis for major activities, carried out in the past 12 months. Following our implementation plan we concentrated on the dissemination of scientific results, support of research projects and early career scientist as well as conceptual preparation of future research initiatives.

Important Issues or Factors: (1) Contributions to **3 international scientific meetings:** (a) SCAR Horizon Scan in Queensland, NZ, (b) SCAR Open Science Conference in Auckland, NZ, (c) AnT-ERA workshop on "Molecular and genetic advances to understanding evolution and biodiversity in the polar regions" in Napoli, IT. The events provided an excellent opportunity for AnT-ERA scientists to communicate with each other and with other initiatives and key global science leaders to shape important research activities in the next years. (2) Support of **early career scientists** was implemented providing mini-grants, to participate in symposia, workshops and conferences but also for working stays in other labs to extend their experience and support of an APECS / AnT-ERA workshop in Hannover, Germany. (3) **Review-paper (Gutt et al. 2015)** provided a new analytic approach of climate-change induced multiple threads of Antarctic marine ecosystems published as a product of AnT-ERA topics 2 & 3 in close cooperation with ACCE and AntClim21. (4) When new "Scientific Highlights" (**popular outreach articles**) on AnT-ERA's homepage are announced through AnT-ERA's mailing list, approx. 90% of the approx. 500 mailing list members visit this homepage.

Recommendations/Actions and Justification: AnT-ERA's SC members are active in their participation and support of research on biological processes in the Antarctic, mainly affected by climate change. Much emphasis has been placed on studying tipping points and the resilience of species and ecosystems, issues of rising importance to the global science community. AnT-ERA contributes successfully to cooperation between single research activities, which require international coordination to achieve the overarching aim of improved understanding of ecosystem functioning. The quality of AnT-ERA's activities depends on both, bringing together the best scientists in their research fields and including as many national programs as possible. In this respect we depend on the support not only of the SCAR secretariat but also of the national programs, represented in the SCAR *Standing Scientific Group of Life Sciences* to the benefit of both, the AnT-ERA community within SCAR and the national programs. Besides such general scientific communication we focus on the dissemination of scientific concepts and results.

Expected Benefits/Outcomes: The main targeted outcome of AnT-ERA in 2015 will be the results of the Cross-program workshop under the leadership of AnT-ERA SC members (Gutt& Isla). We expect to improve interdisciplinary cooperation between Antarctic physicists and biologists, which should attract national and international funding especially for early career scientists.

Partners: We will continue and intensify existing cooperation with AntEco, AntClim21 and ICED. AnT-ERA has been linked with SCAR-EGBAMM internally, PEI (Polar Educators International) and we sponsored the APECS workshop in Hannover. AnT-ERA contributes to EU-PolarNet.

Budget Implications: We appreciate the support of the SCAR secretariat and hope to receive the same budget for the next financial period, which provides a valuable basis for our mission to coordinate, disseminate and communicate research activities, results and experience.

1. Rationale for the Programme

(modified from the implementation plan)

Environmental change occurs across broad temporal and spatial scales. Recent climate change is slow compared to daily changes, but is much faster than long-term geological scale changes such as glacial cycles. For example, the Antarctic Peninsula is warming very fast: ocean surface temperatures have increased by approximately 2°C, and sea ice extent and persistence have declined markedly since the 1950s; in contrast, sea ice extent and persistence is increasing in the Ross Sea sector, but this increase is predicted to slow and then reverse when the ozone hole closes. Currently, organisms across the planet experience a range of environmental change from less than daily (e.g. tidal) to seasonal and multi-year (e.g. El-Niño, Southern Annular Mode) to medium- and long-term (e.g. Little Ice Age, mid-Holocene warming, glacial cycles). Terrestrial Antarctic species experience daily and seasonal temperature change that marine species have not experienced in millions of years, and possibly never. Although regions of continental Antarctica are cooling, there has been an increase in warming events, which affect permafrost and the physiologies of their associated terrestrial communities. Antarctic species have evolved special adaptations to extreme environments that suggest their responses to climate change may differ from species elsewhere. All Antarctic ecosystems (marine, terrestrial, freshwater, subglacial lakes and cryoconites) are vulnerable to environmental, especially climate, changes. However, the possible responses of organisms to environmental change vary markedly across process scales, from gene to ecosystem, and spatial scales from nanometre to regional.

As a consequence, AnT-ERA is focussing on current biological **processes** that may reflect a cascade of responses to environmental forcing - from molecular and physiological to those at the organismic and ecosystem levels. AnT-ERA has three overlapping general themes:

- 1) Assessment of when, where, and how climate change affects **molecular and physiological performance**, and which performances will improve abilities to cope with change or which will be forced across critical thresholds.
- 2) Identification of interactions between drivers and **population processes** (resulting, for example, from species traits) for a predictive understanding of population resilience under future environmental conditions.
- 3) Examination of **ecosystem functions** that are expected to be sensitive to climate-forced changes, and critical to the maintenance of biogeochemical cycles and **ecosystem services**. These include carbon storage, maintenance of biocomplexity, nutrient regeneration, and biomass production.

2. Important Issues or Factors

i) Five Scientific Highlights

The main outputs of the **SCAR Horizon Scan** were two papers (**Kennicutt et al 2014a, 2014b**). The first was a *Nature* comment where the importance of biomolecular approaches in understanding adaptation were emphasised, as were the identification of irreversible environmental thresholds, primarily at the species level. In the second paper, in *Antarctic Science* aspects of the impact on the marine and terrestrial systems due to climate change, including multiple factors and the response of species assemblages and not only single species were additional highlights. Thus, this paper represented a wider output of the Horizon Scan Retreat and the biological part of the 80 high priority questions.

The joint AnT-ERA (topic 2&3) AntClim21 paper (Gutt et al 2014) on the impact of climate change on Southern Ocean biota showed that (i) large proportions of the Southern Ocean are, and will continue to be, affected by one or more climate change processes; areas affected in the future will be larger than those already under stress, (ii) areas affected by sea-ice changes in the past and future are larger than areas that experience ocean warming. Aragonite undersaturation (ocean acidification) might become (in terms of area affected) one of the biggest problems for the Antarctic marine ecosystem in future decades. Direct and indirect impacts of various environmental changes to the three major habitats (sea-ice, pelagic and benthos

and their biota) are shown to be complex and are assumed to be mostly non-linear. Areas affected by environmental stressors range from 33% for a single stressor, to <1% for four and five overlapping factors. In the future, areas expected to be affected by two and three overlapping factors are equally large, and together cover almost 86% of the Southern Ocean ecosystem (Gutt et al. 2015).

The study of **Saba et al. (2014)** focused on **changes in the pelagic ecosystem West of the Antarctic Peninsula** and was based on data collected over two decades by the Palmer Long Term Ecological Research program (PAL-LTER). The aim was a better understanding of mechanisms by which climate variability affects multiple trophic levels in food webs to determine ecosystem responses to climate change. Positive anomalies in chlorophyll-a (chl-a), occurring every 4–6 years, are constrained by physical processes in the preceding winter/spring and a negative phase of the Southern Annular Mode (SAM). Favourable conditions for phytoplankton included increased winter ice extent and duration, reduced spring/summer winds, and increased water column stability via enhanced salinity-driven density gradients. Years of positive chl-a anomalies are associated with the initiation of a robust krill cohort the following summer, which is evident in Adelie penguin diets, thus demonstrating tight trophic coupling. Projected climate change in this region was assumed to have a significant, negative impact on phytoplankton biomass, krill recruitment and upper trophic level predators.

In contrast, the study of **Moreau et al. (2014)** showed that an increase in photoinhibition due to climate-induced earlier sea ice retreat and the presence of the ozone hole increasing the exposure to incoming radiation (UVBR, UVAR and PAR) was minor compared to the **overall increase in primary production West of the Antarctic Peninsula**. Climate change had an overall positive impact on primary production. The study was based on data series of ozone thickness (1972–2010), sea ice concentration (1978–2010), sea-surface temperature (1990–2010), incident irradiance (1988–2010) and satellite-derived chlorophyll a concentration (Chl-a, 1997–2010). A photosynthesis/photoinhibition spectral model was applied to satellite-derived data (1997–2010) to compute primary production and to examine the separate impacts of environmental forcing. Since 1978, sea ice retreat has been occurring earlier in the season (in March in 1978 and in late October during the 2000s) while the ozone hole is present in early spring (i.e. August to November) since the early 1990s, increasing the intensity of ultraviolet-B radiation. The WAP waters have warmed over 1990–2010. The modelled primary production rates are in the lower range of previously reported rates. The annual open water primary production in the study area increased from 1997 to 2010 (from 0.73 to 1.03 Tg C yr⁻¹) concomitantly with the increase in the production season length.

Suckling et al. (2014) examined the effects of 2 years exposure to the **environmental stress of lowered pH** (-0.3 and -0.5 pH units) and increased temperature (+2 °C) on the Antarctic sea urchin, *Sterechinus neumayeri*. The time-scale covered two reproductive cycles and analyses included studies on both adult metabolism and larval development. Adults took at least 6–8 months to acclimate to the altered conditions, but beyond this there was no detectable effect of temperature or pH. Animals were spawned after 6 and 17 months exposure to altered conditions, with markedly different outcomes. At 6 months, the percentage hatching and larval survival rates were greatest in the animals kept at 0 °C under current pH conditions, whilst those under lowered pH and +2 °C performed significantly less well. After 17 months, performance was not significantly different across treatments, including controls. However, under the altered conditions sea urchins produced larger eggs compared with control animals. These data show that under long-term culture adult *S. neumayeri* appear to acclimate their metabolic and reproductive physiology to the combined stressors of altered pH and increased temperature, with relatively little measureable effect. The study emphasized the relevance of long-term studies on environmental stress.

ii) Progress against prior work plan, including metrics of performance.

A joint publication **on climate change and SO ecosystems** between AntClim21 and AnT-ERA topics 2 & 3 (Gutt et al. 2015) was a major scientific output of the period that this report covers. The authors classified complex relationships between the climate-change relevant environment and the SO biota. In a 2nd part the impact, based on size of the areas affected including those affected by multiple stressors was quantified. Both were assembled from data for ongoing climate change and future predictions (for extended summary see above).

The **SCAR/AnT-ERA workshop "Molecular and genetic advances to understanding evolution and biodiversity in the polar regions - The legacy of EBA"** in Napoli, Italy, brought together experienced and early career scientists to learn lessons from previous research activities under the umbrella of EBA. The workshop also aimed at the implementation of new ideas in new scientific programs, especially AnT-ERA, with the background of the IPCC report and the SCAR Horizon Scan priority questions.

During an AnT-ERA sponsored **Polarstern PS-81 post-expedition workshop** in Dijon, France, the publication of interdisciplinary scientific results in a special volume of *Polar Biology* was coordinated. The results focussed on biota in a region contrasting both, ongoing climate change with shrinking sea ice and relatively stable environmental conditions, even with temporarily increasing sea-ice.

Outreach and communication work was enhanced using **AnT-ERA's webpage** as an important dynamic platform (<http://www.scar.org/srp/ant-era>). Besides background information on AnT-ERA the main (sub-) page presents scientific highlights with permanently added popular articles and updated news including job opportunities. Each time, when new "scientific highlights" are announced through AnT-ERA's mailing lists the counting of clicks indicates that 90% of the receivers (approx. 450 scientists) immediately visit AnT-ERA's webpage.

The AnT-ERA SC continued to contribute to the regular **ACCE update to the ATCM**. AnT-ERA is the main body that proposes highlights on climate change impacts on Antarctic biota. The updates are selected and then facilitated by G. di Prisco and J. Gutt, both being members of the ACCE advisory group and editors of the original report and being in charge of marine issues.

In the AnT-ERA implementation plan the main focus of financial support was for **early career scientists** to join workshops, symposia including the SCAR Biology Symposium in Barcelona, Spain, the SCAR Open Science Conference in Auckland, New Zealand, the AnT-ERA / APECS workshop in Hannover, Germany, as well as other meetings and visits to other/foreign labs to extend their experience and skills. A total of 16 mini-grants were given to early career scientists and another 7 mini-grants to senior scientists to contribute to the committee and scientific work of AnT-ERA. This high number of grants and minor support of outreach was possible because of a carry-over of unspent EBA-money. Additional activities under the AnT-ERA umbrella were financed by funds obtained by scientists through national and international sources.

Contributions to the **SCAR Horizon Scan**. Five members of AnT-ERA's scientific steering committee (**Peck, Schloss, Gutt, Wall, Xavier**) were invited to contribute to the Retreat and the two papers representing the output of this important academic exercise. Through this involvement AnT-ERA scientists not only contributed with their own ideas to future scientific trends, but also represented the AnT-ERA community view. Some SC members (Peck, Gutt, Xavier) were also invited to coordinate the discussion and selection of the most important questions. Through this involvement many AnT-ERA scientists contributed input to and also to the dissemination of the results of the Antarctic Horizon Scan within their own scientific communities and national programs. This AnT-ERA input amplified the overall value of this important event.

Research under the umbrella of AnT-ERA was presented during the **OSC in Auckland** in three sessions, lead by AnT-ERA scientists (Gutt, Isla, Schloss, Verde, Cummings) and representing AnT-ERAs three scientific topics. A fourth session focussed on interdisciplinary issues, especially between AnT-ERA and AntClim 21 including aspects of ICED (convener: Gutt). In an ACCE workshop future plans for interdisciplinary research were initiated by G. di Prisco and further actions were discussed by J. Gutt and J. Turner. Members of the AnT-ERA SC participated in the AntEco workshop "Environmental drivers of Antarctic biodiversity at different spatial scales".

AnT-ERA scientists further contributed to the **SCAR Biogeography Atlas**, of which biodiversity structure is the focus rather than processes, which are the main target of AnT-ERA. However, AnT-ERA scientists have important contributions to make to these fields, and this type of input also demonstrates the important collaborations between SCAR programmes and science areas that are facilitated by joint actions. The Biogeography Atlas is an impressive SCAR / CAML output which forms an extremely valuable basis for ecological process studies. AnT-ERA scientists provided several data sets and chapters and contributed to the editing of the book.

3. Outputs/Deliverables

Publications:

- Adams B.J, **Wall DH**, Virginia RA, Broos E, Knox MA. 2014. Ecological biogeography of the terrestrial nematodes of Victoria Land, Antarctica. *ZooKeys*. 419, 29–71. doi:10.3897/zookeys.419.7180
- Agostini C, Patarnello T, Ashford JR, et al. 2015. Genetic differentiation in the ice dependent fish *Pleuragramma antarctica* along the Antarctic Peninsula. *Journal of Biogeography*
- Ball B, Virginia RA 2014. Microbial biomass and respiration responses to nitrogen fertilization in a polar desert. *Polar Biology*
- Clusella-Trullas S, Boardman L, Faulkner KT, **Peck LS**, Chown SL (2014) Effects of temperature on heat-shock responses and survival of two species of marine invertebrates from sub-Antarctic Marion Island. *Antarctic Science* 26, 145-152
- Cross, E. L., **Peck**, L. S., and Harper, E. M. (2015). Ocean acidification does not impact shell growth or repair of the Antarctic brachiopod *Liothyrella uva* (Broderip, 1833). *J Exp Mar Biol Ecol* 462, 29-35.
- Crossin G, Takahashi A, Sakamoto K, Trathan P, Williams T 2015. Habitat selection of foraging macaroni penguins correlates with hematocrit, an index of aerobic condition. *Marine Ecology Progress Series*, in press.
- Cullis JDS, Stanish LF, McKnight DM. 2014. Diel flow pulses drive particulate organic matter transport from microbial mats in a glacial meltwater stream in the McMurdo Dry Valleys. *Water Resources Research* 50: 86-97
- De Broyer C, Koubbi P, Griffiths HJ, Raymond B, d'Udekem d'Acoz C, Van de Putte AP, Danis B, David B, Grant S, **Gutt J**, Held C, Hosie G, Huettmann F, Post A, Ropert-Coudert Y 2014. *Biogeographic Atlas of the Southern Ocean*. SCAR, Cambridge
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- Duhamel G, Hulley P-A, Causse R, Koubbi P, Vacchi M, Pruvost P, Vignetta S, Irissou J-O, Mormède S, Belchier M, Dettai A, Detrich HW, **Gutt J**, Jones CD, Kock K-H, Lopez Abellan LJ, Van de Putte AP (2014) 7. Biogeographic patterns of fish. In: De Broyer C, Koubbi P, Griffiths HJ et al (eds). *Biogeographic Atlas of the Southern Ocean*. SCAR, Cambridge, pp 328-362
- Froy H, Lewis S, Catry P, Bishop CM, Forster IP, Fukuda A, Higuchi H, Phalan B, **Xavier JC**, Nussey DH, Phillip RA 2015. Age-related variation in foraging behaviour in the wandering albatross at South Georgia: No evidence for senescence. *PLoSOne* 10(1): e0116415. doi:10.1371/journal.pone.0116415
- Geyer KM, Altrichter AE, Takacs-Vesbach C, Gooseff MN, Barrett JE 2014. Bacterial community composition of divergent soil habitats from a polar desert. *FEMS Microbiology Ecology* 89: 490-494
- Gutt J**, Bertler N, **Bracegirdle TJ**, Buschmann A, Comiso J, Hosie G, **Isla E**, **Schloss IR**, **Smith CR**, Tournadre J, **Xavier JC** 2015. The Southern Ocean ecosystem under multiple climate change stresses - an integrated circumpolar assessment. *Global Change Biology* 21, 1434-1453
- Gutt J**, Piepenburg D, Voß J 2014. Asteroids, ophiuroids and holothurians from the southeastern Weddell Sea (Southern Ocean). *ZooKeys* 434: 1-15
- Gutt J**, DeBroyer C, Gerdes D, Griffiths H, **Isla E** 2014. Zoobenthos - Shelf and slope. In: Teschke K, Bester MN, Bornemann H, ..., **Gutt J** et al. 2014. Scientific background document in support of the development of a CCAMLR MPA in the Weddell Sea (Antarctica) - Version 2014. CCAMLR-paper: SC-CAMLR-XXXIII/BG/02
- Gutt J**, Barnes DKA, Lockhart SJ (2014) 5.28. Classification and spatially explicit illustration of Antarctic macrobenthic assemblages: a feasibility study. In: De Broyer C, Koubbi P, Griffiths HJ, Raymond B, d'Udekem d'Acoz C, Van de Putte AP, Danis B, David B, Grant S, **Gutt J**, Held C, Hosie G, Huettmann F, Post A, Ropert-Coudert Y (eds). *Biogeographic Atlas of the Southern Ocean*. Cambridge, pp 229-332
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- Kennicutt II MC, Chown SL, Cassano JJ, ..., **Gutt J**, ..., **Wall DH**, Walsh JC, Wilson G, Winther JG, **Xavier JC**, Yang H, Sutherland WJ 2014. A roadmap for Antarctic and Southern Ocean science for the next two decades and beyond. *Antarct Sci*, doi:10.1017/S0954102014000674
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- Lavoie C, Domack EW, Pettit EC, Scambos TA, Larter RD, Schenke H-W, Yoo K-C, **Gutt J**, Wellner J, Canals M, Anderson JB, Amblas D (2015) Configuration of the Northern Antarctic Peninsula Ice Sheet at LGM based on a new synthesis of seabed imagery. *The Cryosphere* 9: 613-629
- Levy JS, Fountain AG, Gooseff MN, Barrett JE, VanTreese R, Welch KA, Lyons WB, Nielsen UN, **Wall DH** 2014. Water track modification of soil ecosystems in the Lake Hoare Basin, Taylor Valley, Antarctica. *Antarctic Science* 26: 153-162.
- Loureiro J, Tavares D, Ferreira S, Seco J, Valente T, Trathan P, Barbosa A, Chipev N, **Xavier JC** 2014. Sex identification in Gentoo (*Pygoscelis papua*) and Chinstrap (*Pygoscelis antarctica*) penguins: Can flow cytometry be used as a reliable identification method? *Journal of Experimental Marine Biology and Ecology* 461: 364-370
- Moon H-W, Wan Hussin WMA, Kim H-C, **Ahn I-Y** 2015. The impacts of climate change on Antarctic nearshore megafaunal benthic assemblages in a glacial fjord on King George Island: Responses and implications. *Ecological Indicators* 57: 280-292
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- Raymond B, Lea M-A, Patterson T, ..., **Xavier JC** 2014. Southern Ocean squid. In: De Broyer C, Koubbi P, Griffiths HJ, ..., **Gutt J**, et al. (eds). *Biogeographic Atlas of the Southern Ocean*. Cambridge, pp 284-289
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- Sleight VA, Thorne MAS, **Peck LS**, Clark MS 2015. Transcriptomic response to shell damage in the Antarctic clam, *Laternula elliptica*: Time scales and spatial localisation *Marine Genomics* **20**: 45–55, doi:10.1016/j.margen.2015.01.009
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- Van Horn DJ, Okie JG, Buelow HN, et al. 2014. Soil microbial responses to increased moisture and organic resources along a salinity gradient in a polar desert. *Applied and Environmental Microbiology* 80: 3034-3043

- Xavier JC**, Walker K, Elliott G, Chereil Y, Thompson D 2014. Cephalopod fauna of South Pacific waters: new information from breeding New Zealand wandering albatrosses. *Marine Ecology Progress Series* 513: 131-142
- Young EF, Belchier M, Hauser L, et al 2015. Oceanography and life history predict contrasting genetic population structure in two Antarctic fish species. *Evolutionary Applications*, doi:10.1111/eva.12259
- Yuan X, Vick-Majors TJ, Morgan-Kiss RM, Priscu JC, Amaral-Zettler LA 2014. Ciliate diversity, community structure and novel taxa in lakes of the McMurdo Dry Valleys, Antarctica. *Biological Bulletin* 227: 175-190

Talks:

- Bylenga C, **Cummings V**, Barr N, Ken Ryan K 2014. Biodeposit production in the Antarctic clam, *Laternula elliptica*, under pH stress. Presented at the 7th New Zealand Ocean Acidification Workshop, *Ocean acidification: the acid test - research priorities in a changing ocean*. Wellington, 11-12th February.
- Cummings V**, Lohrer D, Barr N, et al. 2014. Antarctic sea ice communities, ocean warming and acidification: *in situ* experimental manipulations. Poster presented at the 7th New Zealand Ocean Acidification Workshop, *Ocean acidification: the acid test - research priorities in a changing ocean*. Wellington, 11-12th February.
- Cummings VJ**, Lohrer D, Barr N, et al. 2014. Response of Antarctic sea ice communities to future predicted ocean acidification and warming: results of *in situ* experimental manipulations. Invited presentation at the XXXIII SCAR Open Science Conference, 25-28 August.
- Cummings VJ**, Lohrer D, Barr N, Marriott P, et al. 2015. Antarctic sea ice communities and ocean acidification: novel *in situ* experimental manipulations. Oral presentation at the 8th New Zealand Ocean Acidification workshop: *Ocean Acidification in New Zealand: present state, pHuture directions*, Dunedin. February 10-11.
- Gutt J** 2014. Antarctic Thresholds - Ecosystem Resilience and Adaptation (AnT-ERA) / SCAR Horizon Scan. SCAR AnT-ERA workshop "Molecular and genetic advances to understanding evolution and biodiversity in the polar regions - The legacy of EBA" October 2nd-3rd, Napoli, Italy.
- Hill S, Cavanagh R, Grant S, Rock F, **Xavier JC**, Murphy E, Trathan P 2014. Managing Southern Ocean fisheries to protect other ecosystem services. SCAR Open Science Conference, Auckland, New Zealand, Aug 25-28, 2014 (Talk)
- Kruger L, Ramos J, **Xavier JC**, Paiva V, Petry MV 2014. Oceanographic characteristics explain sexual segregation in foraging habitats by giant petrels. SCAR Open Science Conference, Auckland, New Zealand, Aug 25-28, 2014 (Talk)
- Lohrer D, **Cummings V**, Barr N, Thrush S 2014. The processing of detrital algal food pulses by benthic soft-sediment communities in coastal Antarctica. Presented at the New Zealand Marine Sciences Society Conference, Nelson, August 8-11
- Lohrer D, **Cummings V**, Barr N, et al. 2014. Bottom-up and upside-down: assessment of algal productivity on the underside of coastal sea ice, and the processing of detrital algal food pulses by benthic soft-sediments. Invited presentation at the XXXIII SCAR Open Science Conference, 25-28 August.
- Pedro S, **Xavier JC**, Tavares S, et al. Feathers as a tool to assess mercury contamination in Gentoo penguins: variations at the individual level. VI Portuguese Polar Conference, Oporto. 31st October 2014 (Oral presentation)
- Takahashi A**. Antarctic coastal marine ecosystems as seen through the eyes of Adelie penguins (invited talk). Gordon Research Conference, Polar Marine Science, Renaissance Tuscany Il Ciocco, Italy, 15-20 March 2015
- Xavier JC**, Lourenço S, Seco J et al. Southern Ocean ecosystems: a review of potential impacts of environmental change in the future. VI Portuguese Polar Conference, Oporto. 31st October 2014 (Plenary Talk)
- Xavier JC**, Azinhaga P. Polar Education & Outreach in Portugal: connecting science, education, outreach and policy making to the world. VI Portuguese Polar Conference, Oporto. 31st October 2014 (Talk)
- Xavier JC**, Nieuwendam A. APECS Portugal: the origin. V APECS Portugal Workshop. Oporto. 30 October (Talk)
- Xavier JC** 2014. Colossal squid. In *Animal Bytes*, Cambridge University, Oct. 2014
- Xavier JC** 2014. Polar Science and career development. In II Career development workshop & III Symposium APECS Brazil. Sept. 2014 (2 mini-courses + 3 talks + 4 discussion panels)
- Xavier JC**, Huffman L, Walton D, May I, Costa E, Fugmann G 2014. Antarctic education and Outreach: developing top-bottom and bottom-up initiatives. SCAR Open Science Conference, Auckland, New Zealand, Aug 25-28, 2014 (Talk)
- Xavier JC**, ..., **Peck L**, **Isla E**, **Smith C**, **Schloss I**, **Gutt J**, Constable A, Murphy E 2014. Effects of environmental change on ecosystem services in the Southern Ocean: the role of pelagic cephalopods in the context of potential future commercial exploitation. SCAR Open Science Conference, Auckland, New Zealand, Aug 25-28, 2014 (Talk)
- Xavier JC** 2014. What will Antarctica and the Southern Ocean look like in 2065? The 1st Martha T. Muse Fellows Colloquium; 22 April 2014; Queenstown, New Zealand. (Invited Talk)

Databases and information activities:

Sequence data for the *Margarella antarctica* transcriptome (Clark and Thorne (2015) Mar Gen in press) has been deposited in the GenBank SRA, accession number: SRP058232. Contigs available from <http://tinyurl.com/p9nlwww>

Data from a long-term study into the effects of temperature and pH stressors on the Antarctic sea urchin, *Sterechinus neumayeri*, from Suckling, et al (2014) has been deposited in the Polar Data Centre; British Antarctic Survey, Natural Environment Research Council; Cambridge, CB3 0ET, UK. <http://doi.org/wrh>

The RNA-Seq Illumina reads from Sleight et al. (2015) for *Laternula elliptica* have been submitted to the NCBI SRA (Sequence Read Archive), BioProject accession number: PRJNA268918. The updated assembled contig dataset, using the previously published and the current experimental *L. elliptica* data, is available for download from the Polar Data Centre (<http://tinyurl.com/l5uvczh>).

Education and outreach activities:

Cummings VJ 2014. Antarctic marine ecosystems. Café Scientifique, NZ IceFest, Cathedral Square, Christchurch. Saturday October 4th.

Cummings VJ 2014. Ecosystems below the ice: diverse, abundant and vulnerable to environmental change? Antarctic Science talk. Invited presentation at Antarctica New Zealand, 15 August.

Lohrer AM, **Cummings VJ**, Barr N, Thrush SF, Marriott P, Budd R, Notman P, Edhouse S, Bremner D 2014. Under-ice and seafloor linkages in coastal Antarctic ecosystems. Café Scientifique, Invited presentation at NZ IceFest, Cathedral Square, Christchurch. 4 October

Gutt J et al. Continuous development and updates of the AnT-ERA webpage with "Scientific Highlights" and "News"

Xavier JC 2014. Approx. 35 science talks on polar research in schools or events from Portugal

Xavier JC 2014. Approx. 40 interviews to TV network stations Blog writing for the research carried out in New Zealand trip (January-April).

Workshops:

Beck I, Lehmann R, **Xavier JC**, Huffman L. (convenor) Education meets science: bringing polar research into the classrooms. International Polar Education workshop. Hannover 1-4 April 2015

Cummings V (co-PI): INTERACT (International Network for Tracking Ecological Responses in Antarctic Coastal Time-Series). International initiative for monitoring coastal benthic ecosystems in the Ross Sea. Workshop was held immediately prior to the SCAR OSC in Auckland,. Report reference is:

Cummings V (Deputy Chair): ANTOS (Antarctic Nearshore and Terrestrial Observation Systems). Workshop was held during the SCAR OSC in Auckland. This is now a SCAR action group,.

Daniela G, **Verde C, di Prisco G** (convener): AnT-ERA workshop "Molecular and genetic advances to understanding evolution and biodiversity in the polar regions - The legacy of EBA" October 2nd-3rd, 2014.

Gutt J, David B, Saucedo T (convenor) 2014. Polarstern PS-81 post-expedition workshop, Dijon, France 2014.

Xavier JC, Azinhaga P (convenors) Education & Outreach Session. VI Portuguese Polar Conference, Oporto. 31st October 2014

Xavier JC, Verde C, Smith C, Suckling C, di Prisco G, Isla E 2014 (convenor). From Macro to micro – Advances in understanding Antarctic ecosystems functioning services and biomolecular processes Session. SCAR Open Science Conference, Auckland, New Zealand, Aug 25-28, 2014

Carlson D, May I, Cattadori M, Pasteur L, **Xavier JC** 2014 (convenor). Polar topics for conveying climate change. Escite annual conference. The Hague, Netherlands, May 2014

Xavier JC, Brandt A (convenor) 2014. Southern Ocean Life and Ecology session. SCAR Horizon Scan, April 2014

4. Budgetary Implications

(Main Expenditure; reasons for underspend; requested budget over next two years)

The 2014 budget was totally used and the 2015 budget will be completely used, for various AnT-ERA specific actions:

1. Support of the Cross-program (AnT-ERA, AntClim21, AntEco) workshop in Barcelona, Spain, September 2015 (decided)
2. Mini-grants for approx. 5 early career scientists (done & decided)

3. Support of the Hannover APECS workshop, Germany (done)
4. Support of SC meetings: OSC Auckland (done)
5. Support of the IBBR-Workshop in Napoli, Italy (done)
6. A small amount of support for web-page development (done & decided).

The above decisions were made by a financial committee of AnT-ERA (I. Schloss, E. Isla, C. Verde, J. Gutt) to ensure a transparent and democratic process for the expenditure of SCAR funds. We continued with the plan to direct, in years two and three of AnT-ERA, most support to early career scientists in addition to making SC meetings possible. We will follow the lines presented in the implementation plan to support traveling and capacity building of high-end research discussions, including a broad variety of national programs. For adaptation of the financial plan to actual developments (Barcelona workshop) see below.

5. Future Plans

(Future plans over next two years, in particular any deviations from original work plan.)

1. The SCAR Cross Program Workshop on "Interactions between biological and climate processes in the Antarctic" to be held in September 2015 in Barcelona is based on a progressive discussion during the SCAR OSC in Auckland. We identified a need to benefit from this momentum and decided not to wait until 2016, the period when we had originally planned such an event. We will use a major proportion of our funds to support this workshop by attracting appropriate participants. In parallel, we will continue to support early career scientists as an overarching requirement. In addition to the plans from the early phase of AnT-ERA development in 2012 we, thus, may have a scientific output resulting from the Cross Program Workshop, which demands additional scientific efforts of a number of leading AnT-ERA scientists to the benefit of both the scientists and the entire AnT-ERA community including SCAR as the main supporting body.
2. Contributions to structure the OSC in Kuala Lumpur, Malaysia with detailed proposals for two mini-symposia (plenary sessions) and four AnT-ERA related sessions.
3. Continuation of contributions to ACCE updates for the ATCM, especially on changes in the SO ecosystem.
4. Permanent further development of AnT-ERA's dynamic web-page, especially including Scientific Highlights, news, job and other funding opportunities.
5. Details of proposals to spend the 2016/2017 budget will be developed in a SC meeting during the Barcelona workshop in September 2015.
6. Contributions to *Antarctic Environments Portal* by J. Gutt and other SC members.
7. Contributions to a European Polar Research program through EU-PolarNET (**J. Gutt**).
8. A group of scientists from the *Institut de Ciències del Mar-CSIC*, Barcelona, including Enrique Isla, visited the region of the Filchner Depression during expedition ANT-XXIX/9 of RV *Polarstern* in 2014 as part of the under the Ant-ERA framework. This region is interesting for its dense water formation and high biological productivity, which was hypothesized after tracking marine mammals that gather at the continental shelf break. The objective of the group was to analyse whether signals in the sediments could be used to demonstrate high productivity in the water column. The multidisciplinary results from 18 sediment cores are still developing. A second expedition is scheduled for the 2015-2016 summer season because difficult meteorological conditions impeded work on the western flank of the Filchner Depression.
9. Antarctic Nearshore and Terrestrial Observation System (ANTOS) workshop and planning meeting, August 18-19, 2015, University of Waikato, Hamilton, New Zealand (**B. Adams**)
10. Interdisciplinary Antarctic Earth Science Meeting with Shackleton Camp planning workshop, September 20-22, 2015, Sylvan Dale Ranch, Loveland, CO, USA. (**B. Adams**).

Appendix

AnT-ERA Scientific Steering Committee

Theme 1: LLOYD PECK, British Antarctic Survey, High Cross Madingley Rd, Cambridge, CB3 0ET, UK, lspe@bas.ac.uk;

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Theme 2: DIANA WALL, Natural Resources Ecology Laboratory, Colorado State University, Fort Collins, CO, U.S.A., Diana.Wall@colostate.edu,

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Liaison officers, to PS SSG, especially AntClim21: T. Bracegirdle (British Antarctic Survey, BAS); to ICED: E. Murphy (BAS); to ANTOS: D. Wall. APECS representative: C. Suckling (BAS) & T. McIntyre (AWI);

ex officio EASIZ chief officer: Guido di Prisco