CCAMLR

Commission for the Conservation of Antarctic Marine Living Resources
Commission pour la conservation de la faune et la flore marines de l'Antarctique
Комиссия по сохранению морских живых ресурсов Антарктики
Comisión para la Conservación de los Recursos Vivos Marinos Antárticos

SCIENTIFIC COMMITTEE

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# The Scientific Committee on Antarctic Research (SCAR) Annual Report 2016/17

Submitted by SCAR

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## 1. Summary

SCAR is an interdisciplinary body of the International Council for Science (ICSU), and currently includes 43 member countries and nine ICSU unions. SCAR is charged with initiating, developing and coordinating high quality international scientific research in the Antarctic region (including the Southern Ocean).

SCAR's Mission is to advance Antarctic research, including observations from Antarctica, and to promote scientific knowledge, understanding and education on any aspect of the Antarctic region and its role in the Earth System. SCAR also provides independent and objective scientific advice and information to the Antarctic Treaty System and other bodies and facilitates the international exchange of Antarctic information within the scientific community.

Here SCAR reports on recent CCAMLR engagement, recent scientific research of relevance to SC-CAMLR, and forthcoming SCAR activities of mutual interest.

## 2. Introduction

As an official Observer to the Antarctic Treaty, SCAR provides independent, evidence-based, scientific advice to the Antarctic Treaty Consultative Meetings (ATCM) and to those bodies which form part of the broader Antarctic Treaty System such as the Committee on Environmental Protection (CEP) and the CCAMLR Commission. SCAR also provides advice to other bodies such as the United Nations Framework Convention on Climate Change (UNFCCC) and the Intergovernmental Panel on Climate Change (IPCC). In addition to responding to requests for advice, SCAR also identifies issues resulting from greater scientific understanding of the Antarctic region and the Southern Ocean and brings them to the attention of policymakers.

SCAR's coordination of scientific research adds value to national efforts by enabling national researchers to collaborate on large-scale scientific programmes to accomplish objectives not easily obtainable by any single country. SCAR's success depends largely on the quality and timeliness of its scientific outputs and advice. Descriptions of SCAR's research programmes and scientific outputs are available at: www.scar.org.

## 3. Engagement between CCAMLR and SCAR

SCAR and CCAMLR have a history of cooperation, and continue to meet regularly to maintain and develop the relationship by identifying current areas of mutual interest. The importance of mutually beneficial interactions and information exchange was re-affirmed during a meeting of Parties and Observers contributing to the CCAMLR Performance Review (held in the margins of the recent CEP/ATCM meeting in Beijing), and at the recent Working Group on Ecosystem and Management in Buenos Aires where papers were presented by several SCAR subsidiary bodies and affiliated groups including AntEco[1], SOOS[2] and ICED[3].

During these and other discussions between key representatives of both groups, the value of iterative interactions between SCAR and CCAMLR was reiterated. To this end, the Chief Officer of SCAR SC-ATS (the SCAR Group with a key responsibility for external policy-related advice) and the Chair of SC-CAMLR, continue to maintain regular communications regarding priority areas of research and key issues which would benefit from scientific advice from SCAR.

SCAR actively participated in the 2017 CCAMLR Performance Review, providing feedback on past experiences and suggestions for future interactions. SCAR also provided input (in response to a request from Australia) to the draft climate change response work plan, in particular clarifying the role SCAR might play in assisting with the implementation of the priorities identified in this plan. SCAR also attended the Ross Sea region MPA Research and Monitoring Plan Workshop (WS-RMP) in Italy during 2017.

## *4. Scientific research of interest to CCAMLR*

A diverse range of scientific research is currently underway that is relevant to SC-CAMLR. Here we restrict our focus to a few key areas, with an emphasis on research that addresses priorities or key areas of interest. Some of the more relevant outputs and/or activities include:

- Krill research continues on several fronts. Recent studies include a better understanding of the implications of under ice habitat changes[4], factors underlying the formation of krill hotspots[5], and the drivers of Antarctic krill population cycles[6] (See also Focus Issue 1).

- A recent study on pelagic ecosystems brings together information on food web connections across the polar oceans[7]. Analyses of regional food webs processes and the dominant species are fundamental to predicting impacts of change in polar ocean ecosystems.

- Climate change impacts on penguins in the Antarctic will likely be highly site-specific, but a southward contraction in the range of Adélie penguins is expected over the next century[8].

- New estimates of the size of East Antarctic Adélie penguin population have recently been published, together with revised estimates of their food consumption[9]. Recent molecular research suggests that four metapopulations of Emperor penguins should be recognised[10] (see also Focus Issue 2)

- Research into Southern Ocean warming has predicted significant impacts on benthic organisms, with ~80% of species south of the Polar Front predicted to experience a loss in suitable habitat by the end of the century[11].

- Continual progress is being made on understanding ice sheet mass changes and their implications for sea level rise forecasts[12] (See also Focus Issue 3). Other changes in the physical environment continue to have implications for Southern Ocean ecosystems and are outlined in the SCAR Antarctic Climate Change and the Environment Update (BP 16).

- A molecular study on notothenoid fishes has provided important historical context on their evolution, with important implications for the future of these species under climate change[13]

- Research into the distribution of Southern Ocean species continues to progress. Recent published studies have documented the overlap of krill with penguins and seals[14] and humpback whales[15], while the distribution of several species of procellariform seabirds has been used to inform conservation planning in the region[16].

- An emerging issue of interest is the breakup of the Larsen C ice shelf, recently exemplified by the mega iceberg that broke off in July 2017, triggering the CCAMLR ice-shelf collapse conservation measure (CM24-04).

### 4.1 Focus Issue 1 – Large-scale population cycles in Antarctic krill

#### Overview

Antarctic krill typically exhibit a five to six year cycle, which represents the world's largest population cycle in absolute biomass. Previous studies suggested that the cycle is induced by periodic changes in climate; however, using data analysis complemented with modelling of krill growth, development and population dynamics, a recently published study by Ryabov et al. provides strong evidence that intraspecific competition for food is the main driver of this cycle[6]. The study also suggests that external climatological factors possibly influence the phase and synchronization of this cycle over large scales.

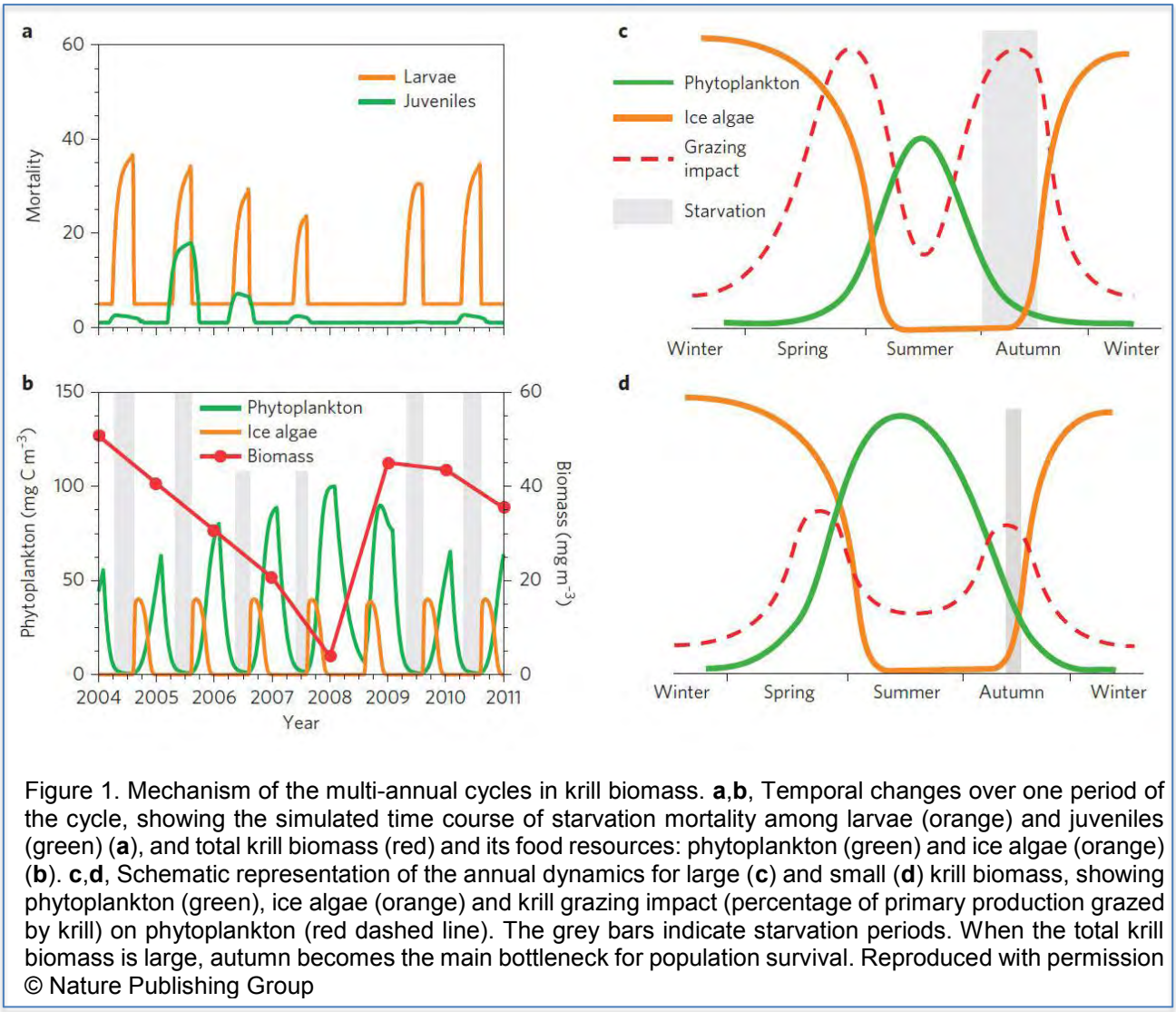


Figure 1. Mechanism of the multi-annual cycles in krill biomass. **a**,**b**, Temporal changes over one period of the cycle, showing the simulated time course of starvation mortality among larvae (orange) and juveniles (green) (**a**), and total krill biomass (red) and its food resources: phytoplankton (green) and ice algae (orange) (**b**). **c**,**d**, Schematic representation of the annual dynamics for large (**c**) and small (**d**) krill biomass, showing phytoplankton (green), ice algae (orange) and krill grazing impact (percentage of primary production grazed by krill) on phytoplankton (red dashed line). The grey bars indicate starvation periods. When the total krill biomass is large, autumn becomes the main bottleneck for population survival. Reproduced with permission © Nature Publishing Group

#### Relevance to SC-CAMLR

One of the key findings of this study was that recruitment to the population is constrained by intraspecific competition when krill biomass is above a critical level, but depends on the environmental conditions when krill biomass is small. The cycle increases with a reduction of krill loss rates and therefore a decline of apex predators is likely to increase the oscillation amplitude, potentially destabilizing the marine food web, with drastic consequences for the entire Antarctic ecosystem.

These findings have important implications for the prediction and assessment of krill population dynamics with particular relevance to whole of ecosystem studies.

### 4.2 Focus Issue 2: Emperor penguin population structure

#### Overview

Emperor penguins have been the focus of several recent population studies and are considered under threat from changing sea-ice condition[17,18]. A study in 2015[19], suggested that there were two distinct populations of this species, one in the Ross Sea and one spanning the Weddell Sea and East Antarctica. A second study published in 2016 provided contrasting results, and suggested that emperor penguins could actually be considered a single population (in terms of their genetic makeup) across the entire Antarctica continent[20]. The most recent study by Younger et al.[10], shows that there are at least four metapopulations of emperor penguins – the Ross Sea, Weddell Sea, Mawson Coast and Amanda Bay/Point Geologie (Figure 2).

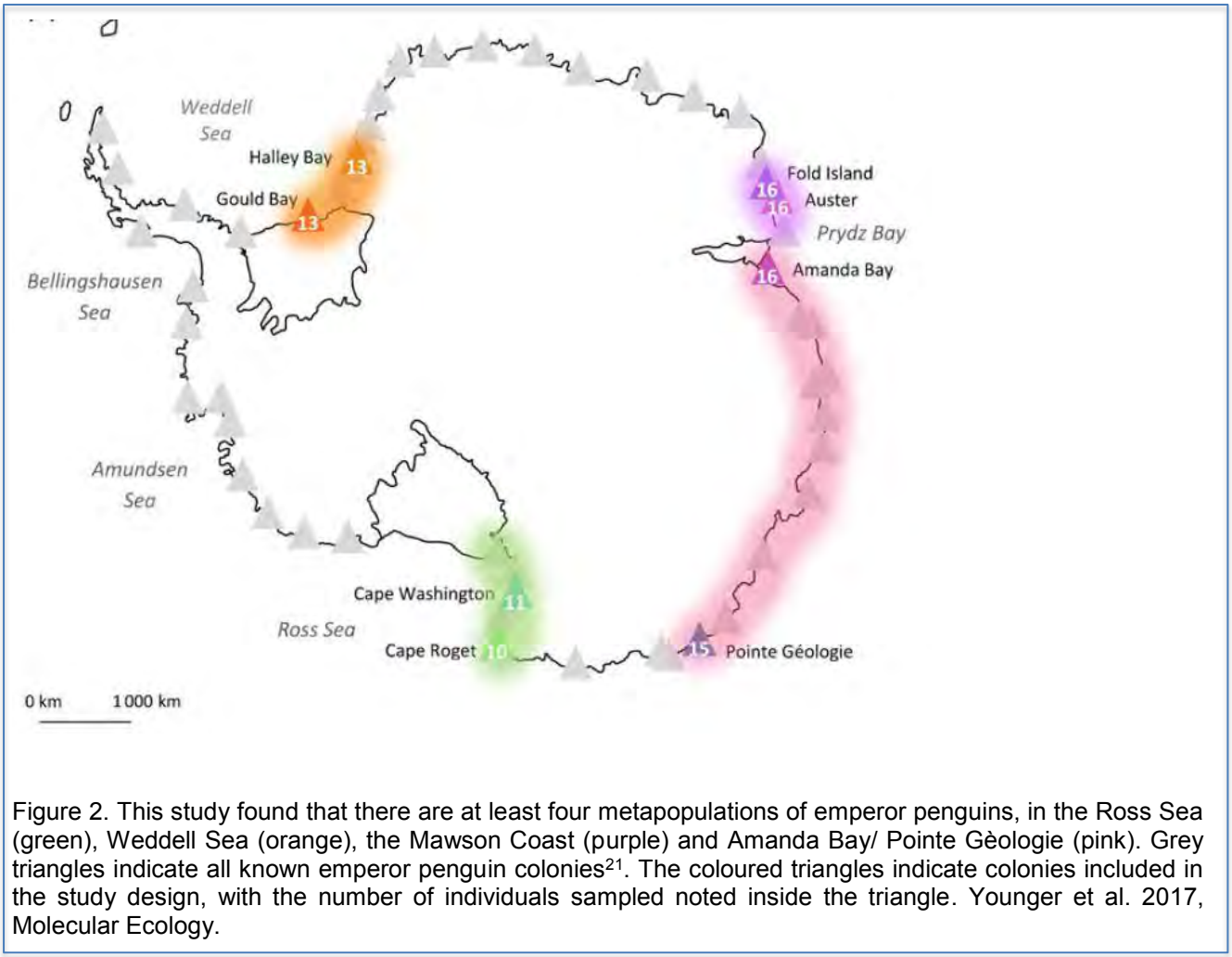


Figure 2. This study found that there are at least four metapopulations of emperor penguins, in the Ross Sea (green), Weddell Sea (orange), the Mawson Coast (purple) and Amanda Bay/ Pointe Gèologie (pink). Grey triangles indicate all known emperor penguin colonies[21]. The coloured triangles indicate colonies included in the study design, with the number of individuals sampled noted inside the triangle. Younger et al. 2017, Molecular Ecology.

#### Relevance to SC-CAMLR

Delineating the geographic boundaries and likely interactions between sub-populations are important for predicting population trajectories and better understanding the role of key predators, like emperor penguins in the Southern Ocean ecosystem. The recent findings presented by Younger et al. reinforce the quickly evolving nature of this field of study and highlight the importance of policy-makers being aware of recent scientific advances.

Understanding penguin distributions and future trajectories is an important aspect of ecosystem-based management. The delineation of emperor penguins into these separate populations helps to clarify questions around their ecology, adaptability and their future management and conservation. However, there are still several populations that have not been represented in these studies (Figure 2) and more research is required to fully resolve the population structure of the species.

### 4.3 Focus Issue 3: Ice sheet mass changes and effects on sea-level rise

#### Overview

Several recent studies have highlighted the implications of melting Antarctic ice sheets particularly with regard to both habitat change and sea level rise[18,19]. A recent study by Forsberg and colleagues[12], uses improved analytical techniques to revise estimates of mass changes, and report on a significant acceleration of mass loss rate in Antarctic ice sheets over the period 2002-2015. The primary changes in Antarctica are associated with the major glaciers in West Antarctica (including the Pine Island and Thwaites glacier systems – Figure 3), as well as on the Antarctic Peninsula where major glacier accelerations have been observed after the 2002 collapse of the Larsen B Ice Shelf.

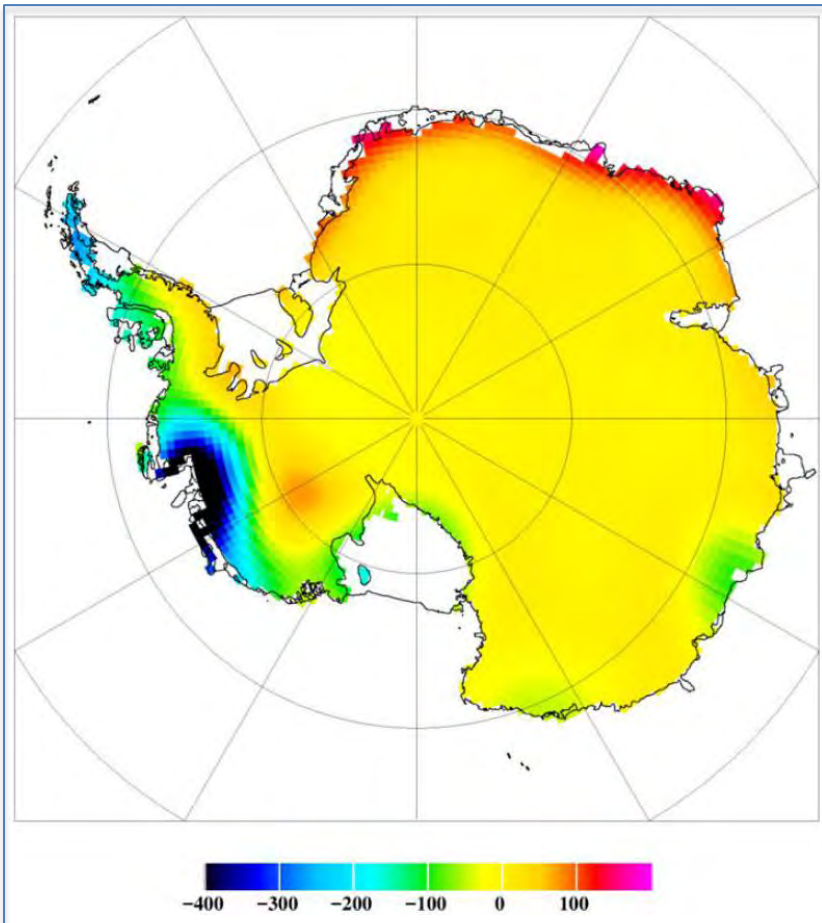


Figure 3. Mass change trends 2002-2016 for Antarctica. Units are in mm water-equivalent /year. Forsberg et al. 2017[12]

#### Relevance to SC-CAMLR

The recent research suggests that melting ice sheets will have the most impact on ecosystems, fisheries stocks and habitat availably across CCAMLR Statistical Subareas 48.1, 88.3 and 48.5. Figure 3 clearly shows change has been rapid in in these areas over the last decade.

Understanding where contemporary environmental changes have been occurring in the physical Antarctica environment, and where they are likely to occur in the future, is an important aspect in predicting flow on effects to biological systems. The work by Forsberg et al. also highlights the benefits of multi-disciplinary research and its capacity to inform ecosystem management.

## 5. SCAR activities of interest to CCAMLR

- Abstract submissions have recently opened for the conference on Marine Ecosystem Assessment of the Southern Ocean 2018 (www.MEASO2018.aq) to be held in Hobart on 9-13 April 2018. This will include a one day policy forum to consider how marine ecosystem science and assessments can assist end-users such as environmental and fisheries NGOs, policy-makers and decision-makers, including CCAMLR. Contact can be made through the web site. Abstracts are due by 30 November 2017

- ICED is planning a workshop to support the work of WG-EMM and SC-CAMLR in the week prior to the MEASO2018 conference. The workshop will focus on Area 48 and consider the drivers of change, the prognosis for sea ice and its impact on availability of krill to predators and the fishery, and examine modelling approaches for Antarctic krill.

- SOOS has a Working Group on Benchmarking Southern Ocean ecosystems that will meet at the time of the MEASO2018 conference in Hobart. This working group is directly relevant to the work of SC-CAMLR and WG-EMM (See BP 14 for more information on this and other relevant SOOS Working Groups).

- SOOS has also established three tools of use to CCAMLR, that will help organise collaborations and data discovery:

    - DueSouth – in which plans for observation and operational activities can be entered into web system to facilitate collaborations
    - SOOSmap – in which historical observations can be located and identified using a GIS tool
    - Federated Data Search tool – that will help locate data in databases and data centres

- SOOS is also proposing a joint SOOS-CCAMLR workshop in April after the MEASO2018 conference to consider how SC-CAMLR and SOOS can collaborate in and streamline the delivery of these products, in order to better support the needs of CCAMLR (See BP 15 for further information).

## 6. Further Information

SCAR produces an electronic Newsletter highlighting relevant science and other SCAR related issues. Please email: info@scar.org if you wish to be added to the mailing list. As well as the web (www.scar.org), SCAR is also available on Facebook, LinkedIn, and Twitter.

SCAR Member countries also have SCAR National Committees, which are responsible for national activities within SCAR (http://www.scar.org/members-and-officers/national-committees). General queries should be addressed to info@scar.org.

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