



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

SC-CAMLR-XXXVII/BG/27

21 September 2018

Original: English

**The Scientific Committee on Antarctic Research (SCAR) Annual  
Report 2017/18**

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Submitted by SCAR



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# The Scientific Committee on Antarctic Research (SCAR) Annual Report 2017/2018

## **1. Summary**

SCAR is an interdisciplinary body of the International Science Council (ISC), and currently includes 44 member countries and nine ISC unions. SCAR is charged with initiating, developing and coordinating high quality international scientific research in, from and about 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 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 for Environmental Protection (CEP) and the CAMLR Commission (CCAMLR). 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](http://www.scar.org).

## **3. Engagement between CCAMLR and SCAR**

SCAR and CCAMLR have a history of cooperation, and representatives of each group continue to meet regularly to maintain and develop the productive working relationship by identifying current areas of mutual interest. The Chief Officer of the SCAR Standing Committee on the Antarctic Treaty System (SCATS - 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.

Two recent developments reflect the commitment of SCAR to continuing and improving engagement with CCAMLR, particularly with regard to the development of research that is relevant to priorities and contemporary discussion within CCAMLR. At the recent SCAR Delegates Meeting in Davos, Switzerland, SCAR Delegates approved the formation of the SCAR Krill Action Group (SKAG), and the Programme Planning Group for a new SCAR Scientific Research Proposal – Integrated Science to Support Antarctic and Southern Ocean Conservation (Ant-ICON). More information on these two new initiatives is provided in Section 5.

#### **4. Recent scientific research of interest to CCAMLR**

While a diverse range of scientific research of relevance to SC-CAMLR is currently underway, here we restrict our focus to a few key areas. Some of the more relevant outputs and/or activities include:

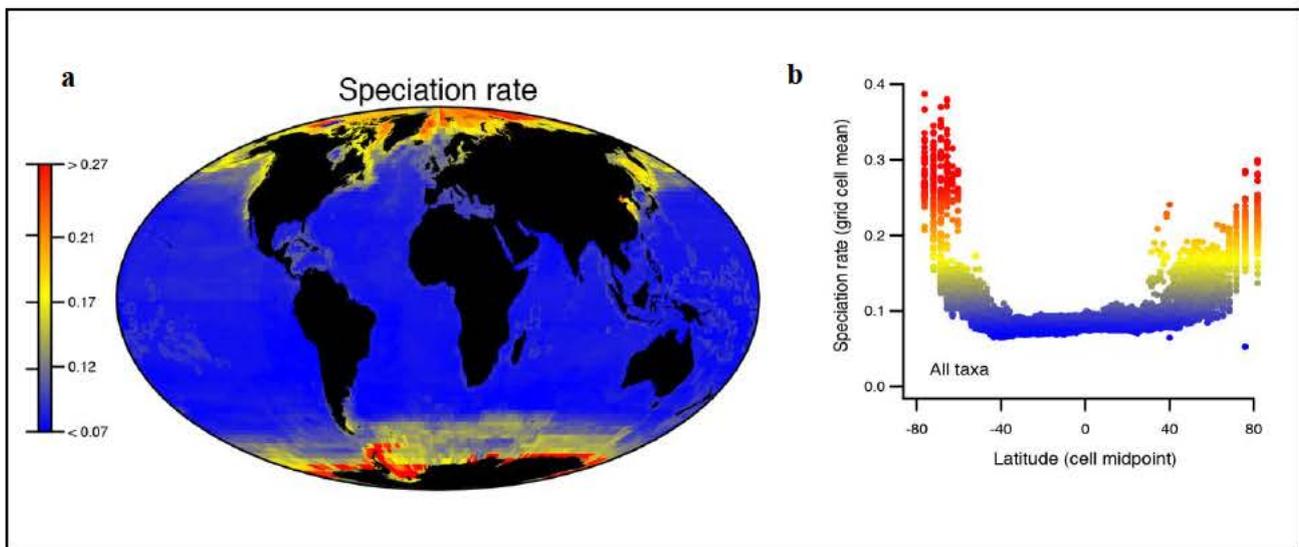
- A global study on the speciation on marine finfish showed that the highest rates of speciation (the evolution of new species) occurs in polar regions<sup>1</sup> (see also Focus Issue 1)
- A continent-wide analysis of Adélie penguin trends was used to assess the suitability of this species as an indicator species for ecosystem health<sup>2</sup>. Their primary finding was that aggregating population abundances across the continent provided the fastest and most reliable signal of true population change.
- Projected warming in Southern Ocean waters may drive adverse consequences for a range of cold-adapted species. In a study of almost 1000 benthic species, Griffiths et al. (2017)<sup>3</sup> showed that most species face a significant reduction in suitable habitat, forcing likely range shifts and flow on impacts for ocean food webs.
- The potential impacts of ocean acidification on a range of taxa continue to be clarified. Experimental work shows that decreases in primary production, reductions in bacterial productivity and dramatic falls in diatom abundance are all associated with increasing carbon dioxide levels<sup>4,5</sup>. These findings have profound implications for nearshore and oceanic food webs under current CO<sub>2</sub> level trajectories.
- Changes in seabird populations continue to be documented across the Southern Ocean (see also Focus Issue 2). These include dramatic declines in some populations of king penguins<sup>6</sup> and changes to their breeding range<sup>7</sup>, massive breeding failures in Adélie penguin colonies in East Antarctica<sup>8</sup> and declines in juvenile survival of snow petrels in response to changing sea ice conditions<sup>9</sup>.
- Using a multi-species, model based approach, Hill et al. (2018)<sup>10</sup> quantified and mapped the distribution of demersal fish assemblages in an ecologically significant region of the Southern Ocean and used their results to assess existing Marine Reserves in the region.
- Ecosystem models were used to project how ocean warming might impact the growth and populations dynamics of Antarctic krill<sup>11</sup>. In this study, declines of krill were predicted to exceed 40% in some areas with flow on effects for predators like penguins. The study also highlighted the complex interactions between krill fishing, ocean warming and Southern Ocean food webs.
- In their article “Choosing the future of Antarctica”, Rintoul et al. (2018)<sup>12</sup> presented two scenarios on the future of Antarctica and the Southern Oceans based on global emissions and policy/governance decisions. These authors highlight that decisions made in the next decade (including on resource use) will be fundamental in driving the conservation trajectories over the next 50 years with much better outcomes under low emissions and effective Antarctic policy and governance.
- A recent study on Antarctic krill provides new insights into the complex interactions between sea-ice and krill<sup>13</sup>. Challenging a dominant Antarctic ecological paradigm, this study finds that the pack ice zone is a food-poor habitat for krill larval development, and that in contrast, the open marginal ice zone provides a more favourable food environment.

## 4.1 Focus Issue 1: Speciation of marine fishes

### Overview

The Southern Ocean is widely known as a region relatively poor in the numbers of fish species that inhabit it, compared with tropical systems such as coral reefs. Indeed, the global latitudinal gradient in species richness – a pattern of high numbers of species in the tropics and lower numbers of species in polar regions – is one of biodiversity's strongest global signals.

New work by Rabosky et al. (2018)<sup>1</sup>, examining not only species richness, but also speciation rate – the rate of the evolutionary process that gives rise to new species – has, however, revealed a surprising finding. *That is, speciation rates are highest in the polar regions.* Significantly, the Southern Ocean includes areas with the highest speciation rates of all, globally (Figure 1). Despite low overall species diversity, new species of fishes are forming in the Southern Ocean at a faster rate than any other marine region.



**Figure 1. Speciation rate variation in marine fishes across the globe.** a. This map shows that the speciation rates for marine fishes are highest in the northern and southern polar regions, and much lower in the tropics. The scale bar indicates rate variation (warm colours = faster rates). b. The speciation rate plotted per geographic grid cell, illustrating very high rates for parts of the Southern Ocean (negative latitudes).

### Relevance to SC-CAMLR

The finding that the Southern Ocean is a region of very high, perhaps the highest, speciation rates globally for marine fish, emphasizes that this region is of tremendous international value. Thus, the CAMLR Convention Area is a key source of marine fish diversity, and thus has contributed profoundly to the resources that underlie a global fishing industry. The CAMLR Convention therefore takes on even more importance. It is pertinent not only to the fish component of Antarctic Marine Living Resources, but also has a profound role to play in conserving the processes that have given rise to global marine fish diversity. Actions taken by CCAMLR to protect the diversity of the region, such as through the designation of Marine Protected Areas, have global implications for diversity and for the evolutionary processes that sustain it, especially over the longer term.

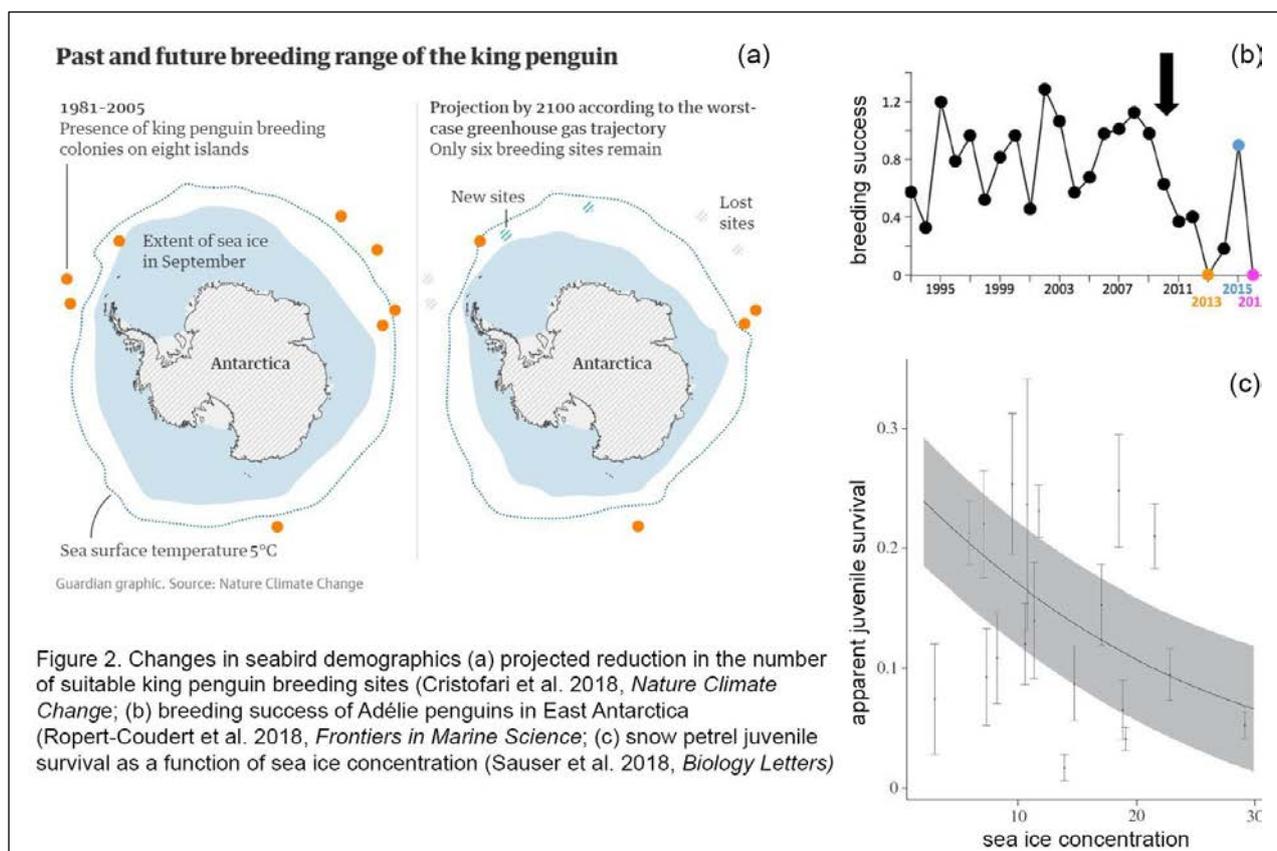
**Acknowledgment:** Daniel Rabosky (University of Michigan, U.S.A.) provided the figures and assisted with the text.

## 4.2 Focus Issue 2: Climate-mediated declines of seabirds

### Overview

As one of the more visible components of pelagic ecosystems, seabirds are often used as indicators of ecosystem health. Identifying and quantifying the connections between changes in seabird breeding ranges, abundances or breeding success, and environmental and/or climatic factors, are key inputs in managing Southern Ocean ecosystems. Three recent studies provide important insights into these connections.

Using a range of demographic, phylogenetic and climate data, Cristofari et al. (2018)<sup>7</sup> predicted that the number of suitable king penguin breeding sites is likely to decline under current climate trajectories (Figure 1a). Mass breeding failures in Adélie penguins in East Antarctica were linked to changes in sea-ice conditions around the colonies, where persistent sea ice made it more difficult for birds to find food at key stages of the breeding cycle<sup>8</sup> (Figure 1b). While, declines in fledgling condition and juvenile survival of snow petrels were also linked to increasing sea ice concentrations and changes in the Southern Annular Mode<sup>9</sup> (Figure 1c).



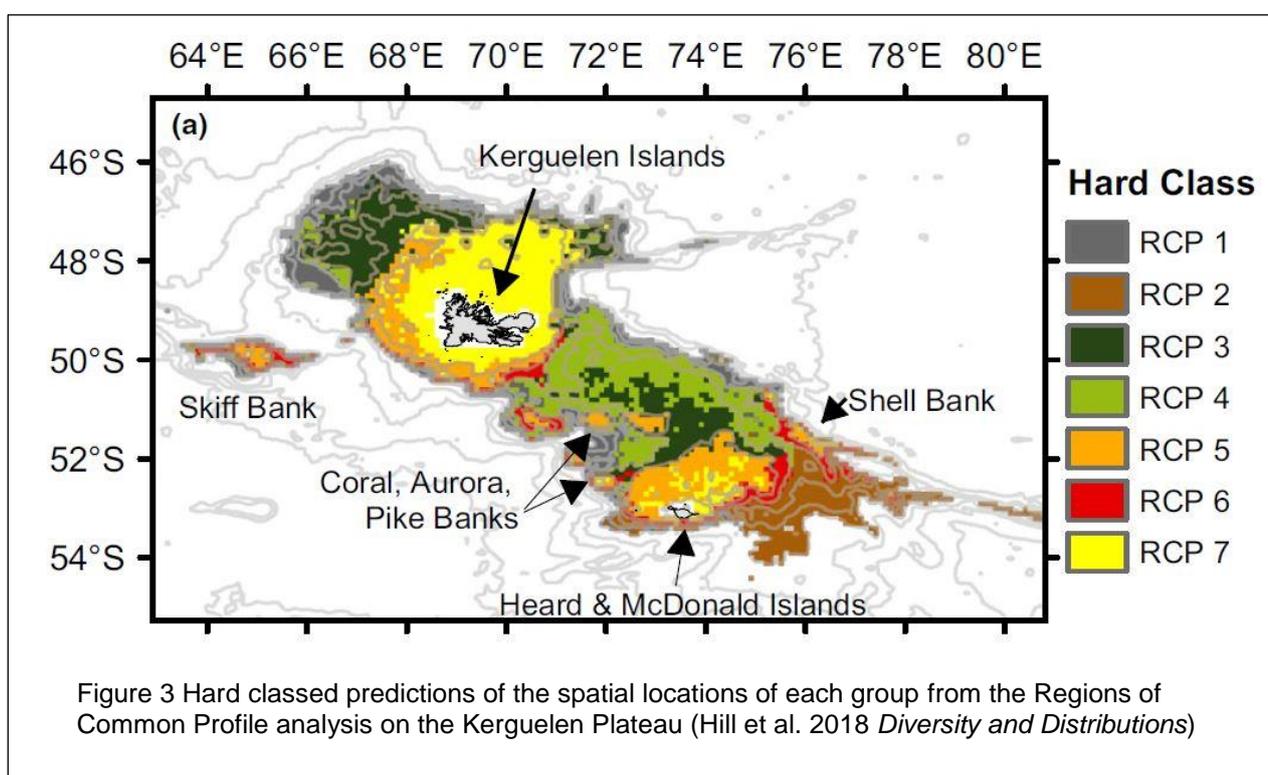
### Relevance to SC-CAMLR

These examples reinforce the potential influence of climate change in driving seabird dynamics in the Southern Ocean. Globally coordinated efforts to reduce greenhouse gas emissions are likely to be one of the most effective ways of reducing climate induced changes over the next decades<sup>12</sup>. However, even under current emissions trajectories, this information can inform management actions and strategies in the region. All three studies provide insights into key areas where species are already or might encounter environmental constraints. A better understanding of these constraints and the associated impacts on the broader ecosystem could greatly assist in the assessment and management of fisheries activities and potentially provide further incentive for the development of Marine Protected Areas<sup>8</sup>.

### 4.3 Focus Issue 3: Modelling demersal fish populations

#### Overview

Understanding and quantifying the distribution of biological assemblages and the links to their environment is a fundamental consideration of any management regime. However, obtaining this information can be challenging, particularly in data poor marine environments. Hill et al. (2018)<sup>10</sup> use a multispecies model based approach to quantify and map the distribution of demersal fish assemblages on the Kerguelen Plateau. This approach, known as Regions of Common Profile (RCP), groups sites with a similar composition of species, and by linking assemblage composition with environmental data, allows the prediction of assemblages across the study area. Through this process they identified seven assemblages (Figure 3), defined by depth, surface temperature and chlorophyll-a. They showed that shallow water assemblages contained a high proportion of endemic species while deep-water assemblages contained more cosmopolitan species. The regions were also used to examine the representativeness of existing Marine Reserves in the region.



#### Relevance to SC-CAMLR

Maps showing the distribution of species or assemblages are important for robust management of biodiversity, particularly for planning or evaluating spatial management. The modelling approach presented here not only provides this broad scale information, but has the added benefit of identifying the species profile for each assemblage. This not only allows assessment of the species composition of each group, but also how these groups (and species) are associated with the environment. The potential of this work, and related methodological extensions, to be utilised in other Southern Ocean areas, especially in relation to considerations associated with planning and evaluating Marine Protected Area proposals and the development of research and monitoring plans for detecting and attributing ecological change, was recognised at the recent CCAMLR Spatial Planning Workshop in Cambridge.

**Acknowledgements** - Nicole Hill (University of Tasmania, Australia) provided the figure and assisted with the text.

## **5. SCAR activities of interest to CCAMLR**

### **Outcomes from SCAR Open Science Conference and Delegates Meeting (July 2018)**

#### ***SCAR Krill Action Group***

The SCAR Krill Action Group (SKAG) was approved by SCAR Delegates at the recent meeting in Davos. SKAG will provide a forum to guide research directions, promote collaboration, improve understanding of krill biology and ecology, and thus assist in providing critical scientific information relevant to krill fishery management. Furthermore, the group will provide a forum for information exchange on upcoming cruises and funding opportunities, as well as lab facilities for experimental krill work, and will serve as a platform for the development of future international collaborative research proposals and programs. SKAG will interact with, and provide essential input to existing SCAR groups such as Integrating Climate and Ecosystem Dynamics in the Southern Ocean - ICED.

#### ***Programme Planning Groups for new SCAR Scientific Research Programmes***

With most current SCAR Scientific Research Programmes (SRPs) coming to an end in 2020, planning is underway for new Scientific Research Programmes, and three Programme Planning groups were approved by SCAR Delegates at the recent meeting in Davos:

- Integrated Science to Support Antarctic and Southern Ocean Conservation (Ant-ICON)
- Near-term Variability and Prediction of the Antarctic Climate System (AntClim<sup>now</sup>)
- Antarctic Ice Sheet Dynamics and Global Sea Level (AISSL)

While all PPGs are likely to focus on science of relevance to CCAMLR, the Ant-ICON PPG will have a particular focus on high-quality science that is relevant to policy makers. While there is a strong biological focus for much of the research, the proposed SRP will integrate research from multiple disciplines, complement existing SCAR activities and work with feedback from policy bodies, including CCAMLR, to achieve conservation outcomes in Antarctica and the Southern Ocean. The SRP will focus on four research themes, broadly covering: i) integrated forecasting of future change to support conservation planning; ii) environmental sustainability of human activities in Antarctica; iii) Antarctic conservation in a global context; and iv) socio-ecological approaches to conservation planning.

#### **Retrospective Analysis of Antarctic Tracking Data (RAATD)**

The Retrospective Analysis of Antarctic Tracking Data (RAATD) is a SCAR project led jointly by the Expert Groups on Birds and Marine Mammals and Antarctic Biodiversity Informatics, and endorsed by the Commission for the Conservation of Antarctic Marine Living Resources. Over the past 9 years RAATD has consolidated tracking data for multiple species of Antarctic meso- and top-predators to identify Areas of Ecological Significance. The first output of the project has now been consolidated in the form of a Data Paper that is currently in minor revision in Nature Scientific Data. This article presents the compiled tracking data from research groups that have worked in the Antarctic since the 1990s. The data are publicly available through SCAR's biodiversity.aq and the Global Biodiversity Information Facility. The archive includes tracking data from over 70 contributors across 12 national Antarctic programs, and includes data from 17 predator species, 4060 individual animals, and over 2.9 million observed locations. The dataset and accompanying syntheses (the second output draft is currently in progress with an aim to be submitted before the end of 2018) will provide a greater understanding of fundamental ecosystem processes in the Southern Ocean, support modelling of predator distributions under future climate scenarios and create inputs that can be incorporated into decision making processes by management authorities.

## **Integrating Climate and Ecosystem Dynamics in the Southern Ocean (ICED)**

A collaborative workshop between the Integrating Climate and Ecosystem Dynamics in the Southern Ocean (ICED) programme and CCAMLR brought together ecologists, physical and ecological modellers and fisheries scientists in Hobart from 5-7 April 2018 to consider the potential impacts of climate change on Antarctic krill in Area 48. The key outcomes of this ICED-CCAMLR Projections Workshop for SC-CAMLR are reported in paper SC-CAMLR-XXXVII/BG/16. The Workshop noted the importance of developing a joint approach between ICED and CCAMLR to improve scenarios and ecosystem models and develop quantified model projections of ecosystem change in support of decision making for conservation and management. ICED is in the process of developing its future work program. In addition to the modelling in support of CCAMLR, ICED is also wishing to establish collaborations in field programs of interest to CCAMLR, including on processes impacting on krill recruitment in the marginal ice zone.

## **Marine Ecosystem Assessment for the Southern Ocean (MEASO)**

The international conference on a Marine Ecosystem Assessment for the Southern Ocean (MEASO) was held in Hobart on 9-13 April 2018. The aim of MEASO is to provide a peer-reviewed synthesis report for updating the marine ecosystem component of the SCAR Antarctic Climate Change and Environment report and, in the first instance, for use by CCAMLR, the CEP and in the sixth assessment review of the IPCC. The 2018 MEASO conference included 180 attendees from 23 countries, spanning scientists, policy-makers, the fishing industry, and environmental NGOs. The program and abstracts are available on the web site ([www.MEASO2018.aq](http://www.MEASO2018.aq)). The conference was focused on four themes that underpin a MEASO: (i) assessments of parts of the ecosystem; (ii) responses of biota to changing environments; (iii) methods for modelling habitats, species and food webs; and (iv) the design of observing systems to measure change in the ecosystem. An important outcome of the conference was a work plan to deliver the first MEASO over the course of 2018. Progress on assembling summaries for the first three components of the assessment is summarised at <http://soki.aq/display/MEASO>.

## **Southern Ocean Observing System (SOOS)**

SOOS has established several regional networks to better coordinate national and international collection of observations in different sectors of the Southern Ocean and has provided a framework for development of community-led Working Groups that enhance observational capabilities. In 2017 four of the five working groups held their inaugural meetings and have made progress on:

- identification of key scientific drivers for the region
- assessments of observational coverage, gaps and priorities for the region
- identification of priority regions for sustained observations and enhanced collaborative efforts

Key SOOS products over the last 12 months include: the Due South Database, the Southern Ocean Community Annual Calendar, SOOS Map, the Southern Ocean Mooring Network, the Federated Data Search Tool and an updated Catalogue of Data Repositories.

## **6. Further Information**

SCAR produces an electronic Newsletter highlighting relevant science and other SCAR related issues. Please email: [info@scar.org](mailto:info@scar.org) if you wish to be added to the mailing list. As well as the web ([www.scar.org](http://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](mailto:info@scar.org).

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