

Scientific Committee on Antarctic Research

Proposal for a *SCAR KRILL Expert Group*

Name of the Proposed Group: To be decided

Name(s) of the lead proponent(s)

Prof. Dr. Bettina Meyer
Dr. So Kawaguchi

Sponsoring Science Group(s) or Standing Committee(s):

Life Sciences

Summary of SCAR Krill Action Group

Recent findings on Antarctic krill, *Euphausia superba* have demonstrated that, even after almost 100 years of research on this species, there remain crucial gaps in our understanding of its life history, response to climate variability, spatial dynamics, and the environmental mechanisms that drive variability of its lifecycle throughout the Southern Ocean (SO).

CCAMLR is an international organization established in response to increasing commercial interest in Antarctic krill resources, a keystone component of the Antarctic ecosystem and a history of over-exploitation of several other marine resources in the Southern Ocean. CCAMLR had a working group focusing solely on krill in its early years but there is no longer a working group within CCAMLR that solely considers krill biology and ecology. The CCAMLR Scientific Committee has emphasised the need for a mechanism to better incorporate the relevant science being done on krill into CCAMLR. Thus a SCAR Krill Action Group (SKAG) was initiated in 2018 to become a prime conduit between CCAMLR and the wider krill science community. SKAG provides a forum to guide research directions, promote collaboration, improve understanding of krill biology and ecology, and through the SCAR Standing Committee on the Antarctic Treaty System, will assist in providing critical scientific information relevant to krill fishery management. Furthermore, the group will provide a forum for an 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 has a close interaction with, and provides input to, the existing SCAR group Integrating Climate and Ecosystem Dynamics in the Southern Ocean - ICED. In addition, because krill are so central to the SO ecosystem, knowledge about krill is essential to answering many of the fundamental questions of groups such as the Expert Group on Birds and Marine Mammals – EGBAMM and the Southern Ocean Continuous Plankton Recorder - SO-CPR.



Proposal for the Creation of an Krill Expert group

1. Introduction and Background

CCAMLR 36 meeting in 2017 recognised the need for increased access to the most up-to-date information on krill biology and ecology to improve CCAMLR's krill fishery management.

One proposed solution was to establish a working group outside of CCAMLR that could synthesise developments in the field of Antarctic krill biology. This group would be led by a krill scientist who also attends the Working Group on Ecosystem Monitoring and Management (WG-EMM), whose remit would be to report the findings of this group to the WG-EMM. WG-EMM would in turn also indicate topics of high priority that could be addressed by researchers in the wider krill community. Such two-way information flow was recognized as enhancing CCAMLR's knowledge on krill and could also stimulate academic research on krill more widely. Such a krill working group would most logically be formed under the auspices of SCAR, providing it with the appropriate level of legitimacy, while at the same time enhancing the relevance of SCAR to CCAMLR, which is a long-standing aim of both bodies. In this respect a proposal was submitted to SCAR to initiate a SCAR krill action group (SKAG), which was approved by SCAR in 2018. The SCAR Standing Committee on the Antarctic Treaty System, which has responsibility for the provision of SCAR advice to the ATS, including CCAMLR, contributed to these proposals.

Many of the key questions identified in the SCAR Horizon Scan require knowledge of krill biology and ecology. SCAR currently has groups that address regional warming, and changes in sea-ice distribution, but there is no SCAR forum for discussing the biological effects of resource extraction, particularly from the largest Southern Ocean fishery - krill. Marine resource extraction may exacerbate the threats associated with warming, ocean acidification and changes in sea-ice distribution, and if so it is critical that we understand how. Although climate change is an important component identified by CCAMLR, the additive effects of marine resource extraction on climate change in Southern Ocean ecosystems have not yet been addressed.

Recent publications on the long-term and seasonal population dynamics of krill (Atkinson et al. 2019, Steinberg et al. 2015, Loeb & Santora 2015, Reiss et al. 2017, Ryabov et al. 2017), krill's link to sea ice (Meyer et al. 2017), as well as their depth distribution, and observed threat from environmental changes (Fuentes et al. 2016) have demonstrated that, even after almost 100 years of krill research, crucial knowledge gaps remain in krill life history, responses to climate change, spatial dynamics, and the environmental mechanisms that drive population variability. Currently no single group within either SCAR or CCAMLR has responsibility for developing a comprehensive understanding of variability in krill life history and spatial dynamics, and the response of the species to climate change, information that is urgently needed to effectively manage the fishery.

Most of the publications listed below were published after the last major synthesis of krill and climate change (Flores et al. 2012). This highlights the importance of this topic and the urgent need to synthesize the plethora of emerging information into a digestible form to help management.

References

- Atkinson A, Hill SL, Pakhomov EA, Siegel V, Reiss CS, Loebe VJ, Steinberg DK, Schmidt K, Tarling GA, Gerrish L, Sailley SF (2019) Krill (*Euphausia superba*) distribution contracts southward during rapid regional warming. *Nature Climate Change*, <https://doi.org/10.1038/s41558-018-0370-z>
- Fuentes V, Alurralde G, Meyer B, Gastón EA, Canepa A, Wölfl A-C, Hass HC, Williams GN,
- Schloss IR (2016) Glacial melting: an overlooked threat to Antarctic krill. *Scientific Reports* 6, 27234, doi: 10.1038/srep27234
- Flores H, Atkinson A, Rebolledo E, Cirelli V, Cuzin-Roudy J, Fielding S, van Franeker JA, Groeneveld JJ, Haraldsson M, Kawaguchi S, Krafft BA, Lombana A, Marschoff E, Meyer B, Milinevsky G, Nicol S, Pakhomov EA, Vande Pute AP, Reiss C, Rombolá E, Schmidt K, Siegel V, Tarling GA, Teschke M, Tonkes H, Toullec J-Y, Trathan PN, Tremblay N, Werner R, Werner T. (2012) Krill and Climate Change. *Marine Ecology Progress Series*. 458: 1-19
- Loeb VJ, Santora JA (2015) Climate variability and spatiotemporal dynamics of five Southern Ocean krill species. *Progress in Oceanography*, 134: 93-122
- Meyer B, Freier U, Grimm V, Groeneveld J, Hunt BPV, Kerwath S, King R, Klaas C, Pakhomov E, Meiners KM, Melbourne-Thomas J, Murphy EJ, Thorpe SE, Stammerjohn S, Wolf-Gladrow D, Auerswald L, Götz A, Halbach L, Jarman S, Kawaguchi S, Krumpen T, Nehrke G, Ricker R, Sumner M, Teschke M, Trebilco R, Yilmaz IN. (2017) The winter pack-ice zone provides a sheltered but food-poor habitat for larval Antarctic krill. *Nature Ecology & Evolution*, doi.org/10.1038/s41559-017-0368-3
- Reiss CS, Cossio A, Santora JA, Dietrich KS, Murray A, Mitchell BG, Walsh J, Weiss EL, Gimpel C, Jones CD, Watters GM (2017) Overwinter habitat selection by Antarctic krill under varying sea-ice conditions: implications for top predators and fishery management. *Marine Ecology Progress Series*, 568: 1-16, <https://doi.org/10.3354/meps12099>
- Ryabov AB, de Roos AM, Meyer B, Kawaguchi S, Blasius B (2017) Competition-induced starvation drives large-scale population cycles in Antarctic krill, *Nature Ecology & Evolution*, DOI: 10.1038/s41559-017-0177
- Steinberg D, Ruck KE, Gleiber MR, Garzio LM, Cope JS, Bernard KS, Stammerjohn SE, Schofield OME, Quetin LB, Ross RM (2015) Long-term (1993–2013) changes in macrozooplankton off the Western Antarctic Peninsula. *Deep-Sea Research I*, 101: 54–70

2. Aims, Goals and Objectives

SKAG has two broad aims. The first is to become the prime forum for the discussion of Antarctic krill biology and ecology, where research directions are “guided” and collaborations are promoted. The second is to become, through close collaboration with the SCAR Standing Committee on the Antarctic Treaty System, the major conduit for two—way information flow between CCAMLR and the wider krill science community to assist in providing critical scientific information that matters to krill fishery management.

Advancing our current knowledge on krill will require research in the field and the labs, either on ships, at Antarctic field stations, or back ashore. Ship time is

becoming increasingly difficult to obtain, and space at field stations is limited and often prohibitively costly for funding agencies. It is therefore essential that we begin to coordinate international research efforts and resources. SKAG provides a forum for information exchange on upcoming cruises and opportunities to encourage international collaboration and cooperation in the broader krill science community.

3. Capacity Building, Education and Outreach Plans

There is a need to enhance capacity building in the krill research community. SKAG is an excellent forum for the advertisement of research opportunities and for scientists to collaborate to develop new initiatives that could grow the krill research community. There is also a need for a co-ordinated outreach program on krill. There is enormous amount of information on krill available to the general public including a considerable volume of material produced by bodies such as the krill fishing industry and conservation NGOs from their view points. SKAG would become a trusted source of unbiased scientific information on krill that could be accessed by journalists and by the general public.

4. Proposed Milestone Activities with Timeline

4.1. What have we achieved so far in the SCAR krill action group

Our proposed milestones for the period 2018-2020 were as follows:

1. Identify gaps in current krill research according to existing literature (Task 1).
2. Identify and prioritise new directions for krill research based on the results of Task 1 (above) (Task 2).
3. Develop and maintain a webpage, which mirrors our aims, research results, and developments in capacity building, education and outreach plans (Task 3).
4. Summarize information from Tasks 1 and 2 (above) in a publication in an international peer reviewed journal (Task 4).
5. Develop a proposal to move from a SCAR Krill Action Group to a Krill Expert Group to build a platform for coordinating krill research between CCAMLR and krill scientists outside of CCAMLR into the future (Task 5).

All proposed tasks were achieved by May 2020

In the two annual SKAG meetings (1st meeting in Cambridge, UK, July 2018, and 2nd meeting in Concarneau, France, June 2019), as well as through several online meetings, we implemented task 1, 2 and 4. Task 4 was submitted to Nature Communications Earth & Environment in May 2020.

For task 3 we developed and are currently maintaining and updating a webpage according to our aims: <https://www.scar.org/science/skag/home/>

At our last annual SKAG meeting in Concarneau 2019 we established a management board and set up registration forms for researchers interested in our goals to join SKAG. SKAG started with 12 executive members from which none were

early career scientist. Now, SKAG consist out of 45 executive members from which are 23 early career scientists.

SKAG Chief Officer, Bettina Meyer, currently sits on the SCAR Standing Committee on the Antarctic Treaty System, which allows her to report to CCAMLR meetings on behalf of SCAR. SKAG's outcome in CCAMLR space include:

- SKAG reported its activities and advised important knowledge gaps in krill biology for improving fishery management (WG-EMM 2019 Paragraphs 4.4-4.7 and 7.8; SC-CAMLR-38 Paragraphs 3.23-3.24, 10.1, and 10.12)
- SKAG has been tasked to provide information on Krill spawning and nursery layers for within the frame work of CCAMLR krill fishery management work plan (WG-EMM 2019 Tables 1, 7, and 8; SC-CAMLR-38 Tables 3 and 4)

4.2. Proposed Milestone Activities with Timeline

Milestones

2020	• Quarterly SKAG SKYPE meetings with the management board to discuss our tasks and progress • Drafting and submission of a review article in an international peer reviewed journal • SKAG reporting to CCAMLR WG-EMM on Krill spawning and nursery layers. • Proposal for SKAG to advance to an Krill Expert Group. • Annual SKAG meeting and Joint SKAG-ICED meeting at the SCAR OSC in Hobart. (can not be realized due to COVID 19 pandemic) • SKAG reporting at the SC-CAMLR meeting and CCAMLR meeting in Hobart (can not be realized due to COVID 19 pandemic)
2021	• Organise a workshop "Addressing key krill research questions: the way forward" with Krill Expert Group and CCAMLR members as well as representatives from the krill fishery to discuss strategies how best we can address and implement recommendations in the SKAG paper from 2020. • Submission of the paper from the "Addressing key krill research questions: the way forward" • Quarterly Krill Expert Group SKYPE meetings with the management board to discuss our tasks and progress. • Krill Expert Group reporting to CCAMLR WG-EMM. • Annual Krill Expert Group meeting at the location of CCAMLR WG-EMM. • Krill Expert Group reporting at the SC-CAMLR meeting and CCAMLR meeting in Hobart • Implementation of a paper from the "Improving krill management workshop"
2022	• Implementation of the outcomes from the "Addressing key krill research questions: the way forward " • Quarterly Krill Expert Group SKYPE meetings with the management board to discuss our tasks and progress. • Krill Expert Group reporting to CCAMLR WG-EMM. • Annual Krill Expert Group meeting at the location of CCAMLR WG-EMM. • Krill Expert Group reporting at the SC-CAMLR meeting and CCAMLR meeting in Hobart
2023	• Organising a workshop with Krill Expert Group and CCAMLR members as well as representatives from the krill fishery to develop a funding umbrella to realise research activities to close the open knowledge gaps in krill research to improve Krill-fishery management. • Quarterly SKYPE meetings with the management board to discuss our tasks and progress. • Prepare reports to CCAMLR WG-EMM and SCAR of the progress made since the approval as an Expert Group in 2020.
2024	• Quarterly SKYPE meetings with the management board to discuss our tasks and progress. • SKEG reporting to CCAMLR WG-EMM.
2025	• Quarterly SKYPE meetings with the management board to discuss our tasks and progress. • Prepare reports to CCAMLR WG-EMM and SCAR of the progress and outcome made since the approval as an Expert Group in 2020. • Annual Krill Expert Group meeting at the location of CCAMLR WG-EMM to discuss schedule and milestones for the next 6 years of SKAG activities.

5. Data Management Plans

The results generated from our tasks will be made public on our webpage.

6. Terms of Reference

We propose that our Expert Group will last from 2020 to 2025.

Krill Expert Group will:

- 1) Assist and inform CCAMLR of the latest scientific knowledge on krill biology and ecology to improve management decisions for the krill fishery.
- 2) Identify fundamental gaps and possible new research directions for krill research.
- 3) Organise workshops with SKEG Krill Expert Group and CCAMLR Members as well as representatives from the krill fishery to develop initiatives to close the gaps of scientific knowledge on krill biology to improve management.
- 4) Function as a conduit for the wider krill community outside CCAMLR to access opportunities for research and collaboration, including that with the commercial krill fishing operators.
- 5) Interact with, and provide input to, the existing SCAR groups to improve our understanding of Southern Ocean ecosystems and the impacts of climate change thereon.
- 6) Develop a proposal to continue as a SCAR Krill Expert Group.

7. Budget and Justification

Here we propose that, due to the ongoing nature and relevance of SKAG research to CCAMLR SKAG should evolve into an Expert Group with a duration of 6 years. If this proposal is not approved by SCAR Life Science Delegates, our contingency proposal is that the SKAG Action Group is extended for four years.

Due to institutional circumstances it will not be possible for some members, particularly the early career scientists, to cover costs to attend our annual meetings. In order to realise maximum attendance to our meetings and interaction with CCAMLR, the annual meetings will be scheduled in coordination with CCAMLR WG-EMM meetings. Most of these meetings are held in Europe, therefore, we are requesting a budget to support accommodate travel costs of at least three executive members with emphasis on early career scientists. According to information from a travel agency, return flights from Asia to Europe cost max. 1800€ and which would be the fares distance to come to a meeting in Europe. For a full two days meeting we calculate hotel costs for 4 days. Hotel costs per day per person will be max, 120€. Therefore, we would require to support 3 members to attend the annual meeting and hence a budget of (Hotel: $3 \times 4 \times 120\text{€} = 1440\text{€}$; Travel: $3 \times 1800\text{€} = 5400\text{€}$) a yearly budget of 6840€ = \$7600 USD.

8. Current SKAG Members

Executive group		
Name	Country	Email
Javier Arata Soto	Canada	Javier.Arata@ark-krill.org
Angus Atkinson	UK	aat@pml.ac.uk
Dominik Bahlburg*	GER	dominik.bahlburg@tu-dresden.de
Anna Belcher*	UK	annbel@bas.ac.uk
Kim Bernard	USA	kbernard@coas.oregonstate.edu
Andrew Brierley	UK	asb4@st-andrews.ac.uk
Laurence Clarke	AU	laurence.clarke@aad.gov.au
Jack Conroy*	USA	jaconroy@vims.edu
Giovanni Canduci*	IT	giovanni.canduci@cnr.it
Sara Driscoll	USA	sara.driscoll@awi.de
Ryan Driscoll	USA	ryan.driscoll@awi.de
Andrea De Felice	IT	andrea.defelice@cnr.it
Sophie Fielding	UK	sof@bas.ac.uk
Wilhelm Hagen	GER	whagen@uni-bremen.de
Simeon Hill	UK	sih@bas.ac.uk
So Kawaguchi	AU	So.Kawaguchi@aad.gov.au
Mary K Kane*	USA	marykathkane@gmail.com
Cecilia M. Liszka*	UK	ceclis56@bas.ac.uk
Hui Liu*	CHN	hui.liu.blue@foxmail.com
Zijun Liu*	CHN	zijunliu1990@foxmail.com
Dale Machette*	AUS	dale.maschette@aad.gov.au
Jessica Melvin*	AUS	jessica.melvin@utas.edu.au
Bettina Meyer	GER	bettina.meyer@awi.de
Katharina Michael*	GER	katharina.michael@uni-oldenburg.de
Enrique Marschoff	ARG	marschoff@dna.gov.ar
Eugene Murphy	UK	ejmu@bas.ac.uk
Schuyler Nardelli*	USA	nardelli@marine.rutgers.edu
Frances Anne Perry*	UK	franki1@btinternet.com
Nora-Charlotte Pauli*	GER	npauli@awi.de
Christian Reiss	USA	christian.reiss@noaa.gov
Keith Reid	AU	keith.reid@ccamlr.org
Angelika Renner	NO	Angelika.renner@hi.no
Georgia Robson*	UK	georgia.robson@cefas.co.uk
Emilce Florencia Rombolá*	ARG	rombola_emilce@hotmail.com
Kirsten B Steinke*	USA	steinkki@oregonstate.edu
Mercedes Santos	ARG	mechasantos@yahoo.com.ar
Zephyr Sylvester*	USA	zesy2348@colorado.edu
Geraint Tarling	UK	gant@bas.ac.uk
Stephane Thanassekos		stephane.thanaaekos@ccamlr.org
Sally Thorpe	UK	seth@bas.ac.uk
Phil Trathan	UK	pnt@bas.ac.uk
Devi Veytia*	AUS	devi.veytia@utas.edu.au
Emma Young*	UK	eyoung@bas.ac.uk
Meie Xue*	CHN	mei.xue@foxmail.com
Haiting Zhang*	CHN	Zh.ting@163.com
Guoping ZHU	CHN	gpzhu@shou.edu.cn

9. Webpages and Communication Plans

We like to improve our webpage with more information for early careers scientists and work in close cooperation with these members to meet their requirements.

10. Other notes and comments

One of the prime tasks for SKAG is to develop an education program to encourage students and young scientists to start or continue working on krill by getting input from our early career scientists in the executive group.