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Multinational large-scale krill synoptic survey in CCAMLR Area 48 in 2019 – survey plan and protocol for consideration by SG-ASAM 2018

B.A. Krafft, O.A. Bergstad, T. Knutsen, G. Skaret, G. Macauley, et al.

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Abstract

The objective for the Multinational Large-Scale Krill Synoptic Survey in CCAMLR area 48 in 2019 is to provide an updated estimate of the biomass of Antarctic krill (*Euphausia superba*) used in models to estimate sustainable yield. The planned survey follows, as close as possible, the design of the CCAMLR 2000 survey, that was undertaken in the year 2000. The basis for comparisons will depend on the degree of coverage and methodology and equipment available. The survey will involve the collaborative efforts of Norway, Association of Responsible Krill fishing companies (ARK: companies from Norway, Korea, China and Chile), United Kingdom, Ukraine, Korea and China, and hopefully also other nations that still needs to confirm their participation.

The current survey plan organization is presented for consideration by SG-ASAM. Norway has volunteered to co-ordinate the survey with other members dedicating personnel to specific tasks. It is requested that members who has already made commitments on ship time, also allocate contact personnel as proposed.

This paper has been developed after a wider consultation extending beyond the authors list. It discusses some specific organizational and technical challenges to be considered by SG-ASAM. We request advice from ASAM on "minimum requirements" regarding acoustic instrumentation and sampling gear to achieve approximate consistency with the CCAMLR B0 data collection protocol.

Introduction and Background

During the 2017 session of the CCAMLR Scientific Committee (SC-CAMLR-XXXVI), Norway announced the intention to take the lead in organizing a full-scale survey (acoustics, biology, physics) of Area 48 based on the CCAMLR 2000 survey design, using both research vessels and commercial fishing vessels through an international cooperative effort. Central to this approach would be the first Southern Ocean expedition using Norway's new polar research vessel RV *Kronprins Haakon* (KPH), in operation from mid-2018. The SC and several individual members welcomed this opportunity and responded positively to the initiative which was subsequently reported favorably to the Commission. At this time several nations and the krill industry have confirmed commitments to provide expertise and vessels to contribute to repeating the CCAMLR 2000 survey, and the commitments are sufficient to make a large-scale survey feasible.

In a draft plan circulated to CCAMLR members in December 2017, the objectives and approach of the investigations were described. The investigations comprise two major elements; i.e. 1) the large-scale survey that provides updated estimates of the biomass of krill in Sub-Area 48 last conducted in 2000 (Hewitt et al. 2004; Watkins et al. 2004), and 2) localized land-based predator work combined with prey field observations in support of the further development of Feedback Management Approaches (FBM). (For details about the FBM related work, please see description submitted to the CCAMLR e-group ("Area 48 Krill Survey 2019") in December 2017).

As it is considered imperative to discuss plans and protocols in SG-ASAM, this paper concerns the large-scale survey (Element 1) only. A revised survey plan will be presented to WG-EMM together with plans for work in support of the FBM approaches. The ultimate goal is to present a fully developed plan comprising all aspects to the Scientific Committee in October 2018.

In this first presentation of the large-scale survey plan, specific challenges to be handled during the remaining planning period are highlighted. These concern ship-time commitments, technical aspects /acoustics, biological sampling), staffing of specialists and organization. Potential candidates for coordinating the work tasks described will be consulted during the ASAM meeting and a list of responsible persons will be developed after the meeting.

Ship-time and survey effort

Using the 2000 survey as a template, the nations and industry partners made commitments to survey specific sets of transects or subareas.
The survey will involve the collaborative efforts of Norway, Association of Responsible Krill fishing companies (ARK: companies from Norway, Korea, China and Chile), United Kingdom, Ukraine, Korea and China who has confirmed commitments (Table 1). With these commitments it is feasible to sample all transects operated during the 2000 survey.
In addition, Peru and South Africa have expressed intentions to contribute, but has not yet made firm commitments (* see Figure 1, Table 1).

The industry contribution comprises 35 survey days from ARK members and an additional 6 days from AKER Biomarine. ARK dedicates FV *Cabo de Hornos* for the survey and the same vessel will most likely be used for the 6 additional Aker days. The industry has been attentive to the need for consistency and ease of operations and has thus committed a single rather than multiple vessels.

The RV *Kronprins Haakon* will be dedicated for the coverage by Norway for ca 29.5 days (the KPH will start the cruise in Punta Arenas (Chile) and end in Stanley (Falkland Islands)- in total 46 days is devoted for the large-scale coverage and the FBM related work with this vessel). Korea will contribute with their FV Kwangjaho for 10 days survey near the South Shetland Islands, United Kingdom will perform the Western Core Box transects north of South Georgia contributing 4 days with RRV *Discovery*, and Ukraine will contribute 5 days near South Sandwich Islands with their FV *More Sodruzhestva*, China will contribute for 7 days on transects; their vessel, area coverage, acoustic equipment and trawl gear will be decided shortly.

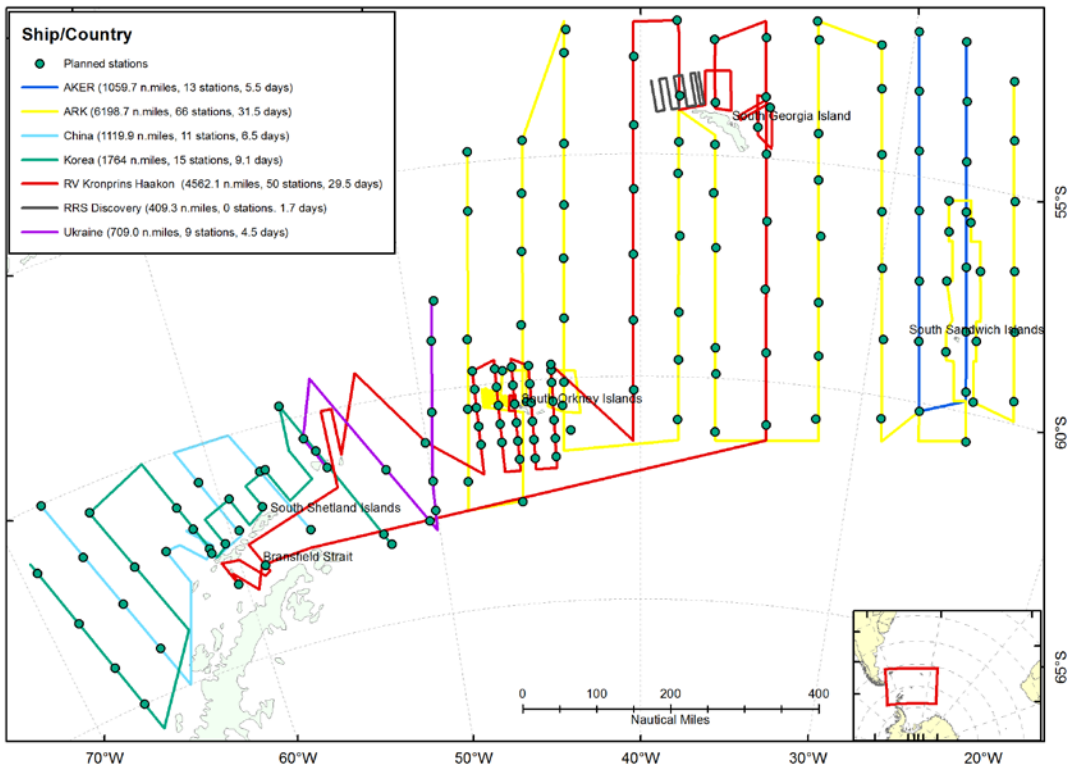

Figure 1. Full coverage of the transect lines from the CCAMLR 2000 survey lines with confirmed participation. The coverage is based on 9 nm/hour cruising speed and an average station-time of 4 hours (vertical CTD casts, plankton nets and trawling). The ARK vessels coverage is based on 2 hours station time (pure trawl station with CTD (Seabird equipment) mounted to the trawl).

Table 1. Nations confirmed with days dedicated for participating to the Large-Scale Survey (LSS) and Feed Back Management (FBM) related work, and nations still not yet confirmed* (total days do not include transit time but actual days on transects, stations).

Nation	Type of research platform	Total days
Norway	RV	20
ARK	FV	35
Aker	FV	7
Korea	FV	10
China	FV	7
Ukraine	FV	5
United Kingdom	RV	4
South Africa	RV	10*
Peru	RV	-*
Russia		Not participating

Challenge:

To reduce uncertainty and facilitate good planning, it is requested that parties intending to participate in the survey provide confirmations before or during the SG-ASAM.

Acoustic survey strategy

Design of tracks

Vessel impacts and design

Ground truthing

1. *Challenges: There has been several modifications to the B0-estimation protocol since the 2000 survey, and we ask SG-ASAM to revise whether the latest protocol is complete and appropriate or if modifications are needed.*
2. *Include opportunities to do some inter-vessel calibration work, as part of the survey design?*

Acoustic instrumentation

Acceptable combinations of frequencies
Within survey monitoring of performance (esp. noise) and acceptable remedies
Calibration
Settings & procedures

Challenges: We ask SG-ASAM to consider exemplary acoustic data acquired from the vessels (we have to request that these are provided, also from logging in passive mode) and recommend if deviance from CCAMLR protocol settings should be considered (for instance due to noise, low operational range at some frequencies etc.)

We ask SG-ASAM to evaluate whether/how uncertainty could be quantified when frequencies are lacking compared to the B0-estimation protocol.

Table 2. Confirmed vessels with frequencies used during the 2000 survey and potential additional acoustic equipment

Vessel	Frequency 38 KHz	120 kHz	200 kHz	Additional acoustic equipment
RV Kronprins Haakon (Norway)	EK80	EK80	EK80	EK80: 18, 70, 200, 333 kHz, Sonars: ME70, MS70, SU90, SH90
RRS Discovery (UK)	EK80	EK80	EK80	EK 80: 18, 70, 333 kHz
FV Cabo de Hornos (ARK)	EK80	ES70		Sonar: Furuno FSV30 21-27 kHz
FV Kwangjaho (Korea)	ES70	ES70		Other frequencies, sonars?
FV More Sodruzhestva (Ukraina)		ES70	ES70	Sonars: Furuno FSV-85 80 kHz, Wesmar HD-850, 110 kHz Echosounders: Koden 28 kHz
China				Missing information

Acoustic data processing and storage

Procedures

Challenges: We ask SG-ASAM to provide advice on a data processing workflow (which software/which output format, which templates, onboard processing or in workshops?)

Strategies for biological sampling and processing

Length frequency distribution of krill is important for conversion of backscattering data to biomass via TS-estimation. The survey will also provide an opportunity to sample other biological characteristics of the krill stock across subareas 48.1 to 48.4.
The entire catch or a random subsample of minimum 100 individuals will be taken for length measurements; taken from the anterior margin of the eye to tip of telson excluding the setae (± 1 mm), according to the "Discovery method" as outlined in Marr (1962).

During the CCAMLR 2000 survey, krill were sampled using a Rectangular Midwater Trawl with an 8 m^2 mouth opening (RMT-8; Baker et al., 1973) near local apparent noon and mid-night each day. The RMT-8 fished obliquely down to 200m and up to the surface. Standard lengths and maturity stages were determined for every krill if the catch was less than 100 animals or a subsample of at least 100 animals if the catch was larger.

Also approved by CCAMLR as a collection tool for the implementation of the annual Norwegian krill survey in 48.2 (since 2011), a "Macroplankton trawl", 45 m long, with a 36 m^2 mouth-opening, constructed of 7 mm diamond shaped meshes (stretched), or a 3 mm light opening, from mouth opening to the cod-end is used. The trawl is towed using a 6-m wide steel beam, and 200 kg weights at each lower wing tip and 1000 kg attached to the beam to ensure fast deployment to depth and best possible geometric stability of the trawl during sampling. Signals from sensors attach to the trawl transfer data to the wheelhouse to monitor trawl operations and are stored for catch calculation. At each station the trawl is lowered vertically from surface to ~200 m depth (or ~20 m above bottom if the water is shallower than 200 m) and then hauled in at ~2.0 knots (including both vessel and wire speed).

The Korean vessel will use a commercial krill trawl with a 15 mm meshed codend for direct sampling of krill.

Table 3. Nets and trawl gear employed by the vessels confirmed participation in the Large Scale survey

Vessel	Trawl/net gear
RV Kronprins Haakon (Norway)	Macroplancton trawl, 7 mm stretched mesh, 3 mm mesh light opening
RV Discovery (UK)	RMT8
FV Cabo de Hornos (ARK and Aker)	Macroplancton trawl, 7 mm stretched mesh, 3 mm mesh light opening
FV Kwangjaho (Korea)	Commercially used krill trawl with 15 mm codend
FV More Sodruzhestva (Ukraina)	Not detemined
China	Missing information

Challenges: The main challenge is ensuring comparability between the different nets available. We request advice from ASAM on resolving this issue and maintaining alignment with the gear used in the CCAMLR 2000 survey (http://archive.ccamlr.org/pu/e/sc/ipy/RMT8protocol.pdf)

Organization, communication and personnel

CCAMLR has an established krill fishery observer programme, which includes protocols for sampling and reporting the biological characteristics of krill.
We note the data could also be submitted to KRILLBASE for inclusion in databases of postlarval density and biological characteristics, which are available to the wider scientific community. The former includes estimates of salp density.

Challenges: The main challenge is to align the data collection and reporting with existing data reporting and management structures.
We request advice on the use of CCAMLR observer programme protocols (for length measurements, catch weighting, sexing and staging) and data reporting processes during the survey. Can the data be reported to and managed by the CCAMLR Secretariat using the observer programme system?

We also request advice on submission of the data to KRILLBASE, and the feasibility of collecting additional salp data.

Data management, post-processing and reporting

The biological data should be worked up into the inputs required for TS-estimation in good time to support the biomass estimation process. This might require analysis to identify the spatial structure of length-frequency distributions. There will be secondary products examining the biological structure of the stock. Two co-leaders will be appointed for this effort, who will also liase with data managers and ensure that the full data set is available to all Members.

We request advice on the priority outputs required from the biological data, the appropriate spatial scales, and the timeline for delivery.

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