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New research consistent with a proposed draft Research and Monitoring Plan for a Ross Sea region MPA

Delegations of New Zealand and the USA

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Abstract

In 2013 New Zealand and the USA submitted a draft research and monitoring plan to accompany a proposal for a Marine Protected Area in the Ross Sea region. In this paper we describe new research projects planned or initiated since submission of that plan, to address priority research activities identified therein. We also identify new research proposals submitted in the past year that are also expected to address priority activities identified in the plan. All CCAMLR Members are encouraged to contribute to this list describing their own planned or ongoing research projects, and to engage in multi-Member collaboration toward the implementation of a genuinely multi-Member ecosystem research and monitoring programme in the Ross Sea region.

Background

In 2013 the Delegations of New Zealand and the USA (2013) presented SC-CAMLR-IM-I-BG/03-Rev1, describing a draft research and monitoring plan to accompany a proposal for a Ross Sea region MPA. This document was a compilation of two separate previous submissions (Watters and Reiss 2012, Pinkerton and Sharp 2012) modified and re-structured geographically in accordance with advice from WG-EMM-12 (paragraph 5.58). A subgroup of the Scientific Committee in 2013 (paragraph 5.45(v)) felt that the draft research and monitoring plan was 'ambitious', and expressed that the plan should include research that is achievable in practice. At the same time, it was recognized that the plan was designed to be broad and inclusive to allow all Members to contribute to joint work programs, and that this would benefit from greater clarity among the CCAMLR community regarding planned or existing on-going research efforts, to facilitate collaboration and data-sharing.

To that end the delegations of New Zealand and the United States provide this paper as an addendum to SC-CAMLR-IM-BG/03-Rev1. This paper describes new research programs that have been already initiated and/or have now been granted funding to deliver research as described in the draft Ross Sea MPA research and monitoring plan. The intention of this paper is:

i) to demonstrate our commitment to continuing to fund ecosystems research and monitoring in the Ross Sea region, where possible in collaboration with other CCAMLR Members;
ii) to raise awareness within the CCAMLR science community of new marine ecosystems research programs in the Ross Sea region, and to facilitate multi-national collaboration
iii) to encourage other Members to likewise initiate and share plans for new research in the Ross Sea region, with the aim of developing a truly multi-national ecosystems research and monitoring programme in the Ross Sea region involving all interested CCAMLR Members

New ecosystems research projects in the Ross Sea region since 2013

The following list is not meant to be comprehensive. We encourage all CCAMLR Members to contribute to this list describing new or existing projects that may contribute to priority research activities identified in SC-CAMLR-IM-I-BG/03-Rev1. We are aware that availability of research funding may vary unpredictably, and that domestic legislative restrictions in some Member countries may make it impossible to express or imply a commitment to new research for which future funding is not guaranteed. Consequently, the absence of described research in this document does not imply that no relevant research is being planned or done by a particular Member; conversely, inclusion of a research project in this list cannot guarantee that the project will be implemented as described or that funding commitments will not change in future.

New Zealand Ross Sea Marine Ecosystems Project

In August 2014 the New Zealand Ministry for Primary Industries (MPI) secured funding for the first year of a planned 5-year programme to investigate the foraging ecology and functional ecological importance of key top predator populations in the Ross Sea region. This collaborative project, dubbed the New Zealand 'Top Predator Alliance' will build upon work that is ongoing or that was begun in the 2013-14 field season, part of which has already been described in submissions to CCAMLR WG-EMM (see below).

The generic and specific objectives of this project are detailed below. The first season of this programme was supported by the New Zealand Antarctic Research Institute (NZARI) with contribution from the UNEP Office Korea, while the second season (2014/15) is funded by MPI. Note that while funding is currently secured through the end of year 2 of the project, the specific objectives below describe planned activities and outputs of the full 5-year programme, continued funding for which is a high priority but remains subject to future decisions. The 'Top Predator Alliance' already includes individual scientists from four CCAMLR Member countries and involves formal partnerships with government or academic research institutions from three Member countries (see Eisert et al. 2014 Appendix). Further opportunities for multi-national collaboration are a high priority and are being actively pursued.

Research objectives were specifically formulated to address priorities identified in SC-CAMLR-IM-I-BG/03-Rev1, as follows.

Generic Objectives:

I. Develop an ongoing research programme to investigate and quantitatively evaluate the abundance, foraging ecology, habitat use, functional importance and resilience of top predators in the Ross Sea region, with the primary focus on killer whales, Weddell seals, Adélie penguins, and Antarctic toothfish;

II. Provide data on top predators in the Ross Sea region to update and refine existing ecosystem models in order to improve their performance and create a new synthetic framework that allows spatially explicit simulation of ecosystem dynamics and multi-species interactions;

III. Use the updated/refined Ross Sea ecosystem models to investigate ecosystem function in this Antarctic marine ecosystem, and hence predict the likely effects of fisheries,

and inform plans for improved protection and management of Antarctic marine living resources.

Specific Objectives:

1. Extend the new killer whale research programme initiated in 2013/14 to investigate the abundance, foraging ecology, and habitat use of killer whale populations in the Ross Sea region, with an emphasis on determining the importance of Antarctic toothfish as prey particularly for Type C or 'fish-eating' killer whales.

2. Extend and develop existing research activities to investigate the abundance, foraging ecology, and likely spatial foraging patterns of Weddell seals in the Ross Sea region, with an emphasis on determining the importance of Antarctic toothfish as prey.

3. Establish the research capability for routine collection of live Antarctic toothfish using baited vertical lines in the McMurdo Sound area; design an ongoing shore-based toothfish sampling and experimental programme to complement existing vessel-based programmes; undertake preliminary lab-based work; and develop procedures and protocols for collecting and maintaining live toothfish in future tank facilities at Scott Base.

4. Extend the existing Adélie penguin research programme on population dynamic and behavioural responses to physical and biological drivers to compare and contrast colonies in the Ross Sea shelf (Cape Bird) and slope (Cape Adare) ecosystems.

5. Update/develop existing multi-species and ecosystem modelling approaches in the Ross Sea region, to investigate and simulate ecosystem dynamics and multi-species interactions using, where possible, spatially explicit models, with a focus on key top predator populations.

Background relevant to the killer whale research (Objective 1) is described in Torres et al. (2013); early successes of the 2013-14 field season are described in Eisert et al. (2014). This research will continue in the 2014-15 field season in the McMurdo Sound area with plans also to extend the research to the Terra Nova Bay area in future years, in partnership with other CCAMLR Members. Formal collaborations are being sought with Russian research institutions to access data available only in Russian (see WG-EMM-14 paragraphs 2.103-2.105).

Background relevant to the Weddell seal research (Objective 2) is described in Eisert et al. (2013). The 2013-14 field season was successful; this research will continue in the 2014-15 field season with interim results planned to be presented to WG-EMM in 2015.

New toothfish field research in McMurdo Sound (Objective 3) will be initiated in the 2014-15 field season, building on the expertise of previous long-term toothfish sampling through the ice in this area (Raymond, 1975; DeVries et al. 2008).

Adélie penguin research and monitoring (Objective 4) builds on an existing multi-year programme in McMurdo Sound (e.g. Lyver et al. 2013, Whitehead et al. 2013) with plans to extend this research to other locations on the Victoria Coast including Cape Adare.

New ecosystem modelling approaches will be developed in later years of the programme to integrate and aid interpretation of results arising from other objectives. This objective will build on existing spatially explicit modelling approaches for the Ross Sea region (Mormede et al. 2014a, Mormede et al. in press) and the existing mass-balanced Ross Sea trophic ecosystem model (Pinkerton and Bradford-Grieve 2014, Pinkerton et al. 2010).

New Zealand Antarctic Marine Foodwebs Voyage 2015

In August 2014 the New Zealand government finalised its commitment to fund a research voyage to the Ross Sea region utilising the R/V Tangaroa to study key aspects of Ross Sea marine foodwebs. The research vessel will be deployed for 45 days between December and February 2014-15.

The main purpose of the Marine Foodwebs Voyage is to undertake ecological studies of Ross Sea marine foodwebs of importance to top predators. The work will be centred on the feeding areas of cetaceans, primarily blue whales and humpback whales near the Balleny Islands, and in the Ross Sea slope area where there is highest fishing intensity. Whales will be located using passive acoustics and visual observations. Observations of prey species will be collected with multifrequency echosounders on *Tangaroa*, combined with midwater and demersal trawling for sample collection to verify the identity of acoustic marks detected by the echosounder. Associated oceanographic observations will be made while underway and with a net-mounted CTD. Samples of prey species,) whale tissue will be collected via dart biopsies, and faeces will be collected for trophic studies using stable isotope and molecular genetic methods. Acoustic and trawl data will provide quantitative estimates of the distribution and abundance of key mid-trophic level pelagic prey species (krill, myctophids, Antarctic silverfish) which are important to cetaceans and other top predator species, and also demersal fish species (grenadiers, icefish) which are important toothfish prey and also appear as bycatch in the toothfish fishery. Trawl samples will also provide information on benthic invertebrate biodiversity.

Research objectives were specifically formulated to address priorities identified in SC-CAMLR-IM-I-BG/03-Rev1, as follows.

Voyage Objectives:

1. Determine composition of acoustic layers associated with humpback feeding areas around the Balleny Islands.

2. Study ecology of foraging blue whales in the northern Ross Sea.

3. Carry out a demersal trawl survey of the Ross Sea slope to provide information relevant to estimating abundances and distributions of grenadiers and icefish.

4. Deploy a moored echosounder to study Antarctic silverfish spawning in Terra Nova Bay during winter.

5. Collect continuous measurement of surface ocean variables to and from the Ross Sea to contribute to oceanographic time-series measurements that traverse the Southern Ocean.

New research proposals utilising toothfish fishing vessels

In 2013 the Scientific Committee endorsed the importance of research priorities for the Ross Sea region involving new surveys by fishing vessels in particular locations (SC-CAMLR-XXXII paragraph 3.76(iv)), and requested that new research proposals be developed. In 2014 research proposals were submitted for new surveys in the south of SSRU 88.2A (Petrov 2014), in the north of SSRUs 88.2A and B (Delegations of New Zealand, Norway and the United Kingdom 2014) and to continue the subadult toothfish survey in the southern Ross Sea shelf (Hanchet et al. 2014). All three of these toothfish surveys have potential relevance for research identified in the draft MPA research and monitoring plan in SC-CAMLR-IM-I-BG/03-Rev1.

U.S. Projects in the Ross Sea Region funded in 2013 and 2014

The following list of projects have recently been funded by the U.S. National Science Foundation (NSF); note that several ongoing projects are not listed here but are relevant to the Ross Sea Region Research and Monitoring Plan. Additional information on the projects listed here and on the other projects (e.g., projects on Weddell seals funded through NSF grant # 1141326, on *Phaeocystis* funded through grant #'s 0944659, 1142095, 1142018, and 1063592 and on benthic invertebrates funded through grant #'s 1043670 and 1043745) is available through http://www.nsf.gov/awards/award_visualization.jsp?org=PLR, and the abstracts presented here are abridged versions of those provided through this website. The projects are numbered to ease identification in the next section of this document; NSF grant numbers (which can aid searches on the NSF website) are provided in square brackets at the end of each abridged abstract. The first two projects listed below are relevant to the research priority, as identified in Annex C of the draft Conservation Measure in CCAMLR-XXXIII/21 of "meteorological and oceanographic research, including satellite remote sensing, to characterize physical properties and dynamics of phytoplankton and zooplankton." The third project will increase knowledge about biodiversity in the Ross Sea region.

NSF1 -- Ocean Acidification Seascape: Linking Natural Variability and Anthropogenic changes in pH and Temperature to Performance in Calcifying Antarctic Marine Invertebrates.

> The research supported in this project will examine the effects of environmental change on a key Antarctic marine invertebrate, a pelagic mollusk, the pteropod, *Limacina helicina antarctica*. There are two main activities in this project: (1) to deploy oceanographic equipment -- in this case, autonomously recording pH sensors called SeaFETs and other devices that record temperature and salinity, and (2) to use these environmental data in the laboratory at McMurdo Station to study the response of the marine invertebrates to future changes in water quality that is expected in the next few decades. Notably, changes in oceanic pH (aka ocean acidification) and ocean warming are projected to be particularly threatening to calcifying marine organisms in cold-water, high latitude seas, making tolerance data on these organisms a critical research need in Antarctic marine ecosystems. These Antarctic shelled-animals are especially vulnerable to dissolution stress from ocean acidification because they currently inhabit seawater that is barely at the saturation level to support biogenic calcification. Indeed, these polar animals are considered to be the 'first responders' to chemical changes in the surface oceans. Thus, this project will lead to information about the adaptive capacity of

L. helcina antarctica. From an ecological perspective this is important because this animal is a critical part of the Antarctic food chain in coastal waters and changes in its abundance will impact other species. [1246202]

NSF2 –

Antarctic coastal polynas are, at the same time, sea-ice free sites and sea-ice factories. They are open water surface locations where water mass transformation and densification occurs, and where direct atmospheric exchanges with the deep ocean circulation are established. Various models of the formation and persistence of these productive and diverse ocean ecosystems are hampered by the relative lack of in situ meteorological and physical oceanographic observations. This is especially so during the inhospitable conditions of their formation and activity during autumn to winter transition and the polar night. The Western Ross Sea, downstream from two of the largest coastal Antarctic polynyas, happens to be a region where there continues to be net sea-ice production, as indicated by satellite measurements of areal extent, duration and concentration. Characterization of the lower atmosphere properties, air-sea surface heat fluxes and corresponding ocean depth profiles of the Terra Nova Bay (TNB) polynya, is sought for a more detailed understanding of the role of polynyas in the production of latent-heat type sea ice and the formation, through sea ice brine rejection, of dense ocean bottom waters. This observational program will simultaneously identify mechanisms responsible for water mass modification within TNB and document aspects of dense shelf water formation within a large Antarctic polynya system. This study will characterize the water masses within a polyna over the course of an annual cycle using moorings yielding in-situ column and near-surface oceanic observation. [1341688]

NSF3 –

SIMPLE- the Sub-ice Investigation of Marine and PLanetary Ecosystems, is a large, predominantly NASA-funded project that will explore the potential for the underside of Antarctica's ice shelves to support vibrant marine ecosystems, despite the constant darkness. A recently discovered "upside down" sea anemone from the underside of the ice was just named one of the top ten new species of 2013 in fact. The current award will support the hot-water drilling needed to allow a remotely operated vehicle (ROV) to survey the underside of the ice during the upcoming Antarctic summer field season of 2014/2015. The NSF provided equipment, teamed with the NASA supported science, represents a synergistic federal partnership to support interesting science in a unique habitat, the underside of Antarctic ice shelves. [1446242]

Links with priority activities identified in the draft Ross Sea region research and monitoring plan

Document SC-CAMLR-IM-I-BG/03-Rev1 identifies priority research and monitoring activities in association with specific objectives of the MPA. Consistent with Scientific Committee advice, these are ordered geographically, with each bulleted point identifying research activities that address more than one objective simultaneously. To ease interpretation the numbering of geographic regions is the same as in SC-CAMLR-IM-I-BG/03-Rev1as follows:

2.1 Ross Sea continental shelf
2.2 Ross Sea continental slope
2.3 Balleny Islands and vicinity
2.4 Northern Ross Sea region and seamounts
2.5 All areas

In this document we identify those bulleted points for which new research is already planned or underway, and identify the source(s) of that new research consistent with the new research projects described above or with submitted CCAMLR documents. Acronyms used are as follows:

- **NZTPA**: New Zealand 'Top Predator Alliance'
- **NZAMF**: New Zealand Antarctic Marine Foodwebs Voyage 2015

Note that individual bullet points are not numbered in SC-CAMLR-IM-I-BG/03-Rev1, so are instead summarized here; see SC-CAMLR-IM-I-BG/03-Rev1 for full descriptions of the identified priority research activities.

2.1 Ross Sea continental shelf

- Expand the existing Weddell seal and Type C killer whale programmes at McMurdo Sound. *[Protection objectives vii(c-d), viii(a-b)]*
  - **NZTPA** Objectives 1-2

- Establish a long-term top predator colony population monitoring programme in the Terra Nova Bay area. *[Protection objectives ii, vii(a-d), viii(b-c)]*
  - **NZTPA** Objectives 1, 2, 4

- Undertake aerial overflights of the Victoria Coast at a frequency of once every 2-3 years, using cameras and semi-automated digital processing technology *[Protection objectives ii, vii(a-d), viii(a-d)]*
  - **NZTPA** Objectives 1, 2

- Continue subadult survey for Antarctic toothfish in southern Ross Sea *[Protection objectives viii(a-d), ix(a-b)]*
  - Hanchet et al. (2014)

- Conduct dedicated research voyage(s) to Ross Sea shelf and slope (every 2-5 years) to measure/monitor distribution of middle trophic levels groups: Antarctic silverfish, crystal and Antarctic krill, octopods, small demersal fishes, zooplankton. *[Protection objectives vi(b-c), viii(a-e)]*
  - **NZAMF** Objective 3.

- Further develop acoustic methods from ships-of-opportunity and research vessels for long-term monitoring of krill, silverfish and myctophids in the Ross Sea region. *[Protection objectives v(a-e), vi(a-c), viii(a-e)]*
  - (LaDroit and O'Driscoll 2014)

- Establish acoustic mooring in Terra Nova Bay, in conjunction with shore and boat-based surveying, to investigate and monitor silverfish ecology over annual cycle, including links to seasonal sea-ice of silverfish and silverfish prey. *[Protection objectives vi(c), viii(c)]*
  - **NZAMF** Objective 4

- Continue and standardize the 35+ year time series programme of Antarctic toothfish sampling through the ice at McMurdo Sound. *[Protection objectives ix(a)]*
  - **NZTPA** Objective 3

- Characterise and monitor McMurdo Sound benthic ecosystem and establish observational transects along Victoria Coast. [Protection objective x(e)]
  - **NSF1**
  - **NSF3**

- Study oceanographic and under-ice flow dynamic properties in coastal locations in the McMurdo Sound and Terra Nova Bay aras. [Protection objective viii(a-e)]
  - **NSF2**
  - **NSF3**

2.2 Ross Sea continental slope

- Research survey of distribution and biomass of medium-sized demersal fish with a focus on species that form the main prey for toothfish in the slope region. *[Protection objectives ii, ix(c)]*
  - **NZAMF** Objective 3

- Initiate archival/satellite tagging of toothfish in Mawson Bank (area of high fisheries yield) to elucidate movement patterns. Continue spatial population modelling of Antarctic toothfish (Mormede et al., 2013). *[Protection objectives ii, v(a), ix(b-c)]*
  - (Parker and Webber 2014)

- Survey of structure-forming benthic invertebrates on the Ross Sea slope *[Protection objectives v(e), viii(e), x(c-d)]*
  - **NZAMF** Objective 3

2.3 Balleny Islands and vicinity

- Estimate numbers of seals and whales near Balleny Islands and establish ecological monitoring of marine mammals. *[Protection objectives v(c)]*
  - **NZAMF** Objectives 1, 2

- Use multifrequency acoustic survey of the Balleny Islands region coupled with mesopelagic net sampling to determine abundance of middle trophic level biota in the region, including krill, zooplankton, squid, and midwater fishes *[Protection objectives v(c), vi(a,c)]*
  - **NZAMF** Objective 1

2.4 Northern Ross Sea region and seamounts

- Conduct scientific voyage(s) to improve knowledge of distribution and abundance of Antarctic and Patagonian toothfish (in particular the unfished areas in the north of SSRUs 88.1A, 88.2A, and 88.2B). *[SC-IM-I paragraphs 2.31(vii) and 2.32]*
  - (Delegations of New Zealand, Norway, and the United Kingdom 2014)

2.5 All areas

- Develop and validat improved higher resolution oceanographic models of the Ross Sea region nested within global climate-ocean models *[Protection objectives ii, v(a-e), viii(a-e)]*
  - **NSF1**
  - **NSF2**

- Apply international best-practice in ecosystem modelling to monitor the performance of the Ross Sea MPA. *[Protection objectives i, ii]*
  - **NZTPA** Objective 5

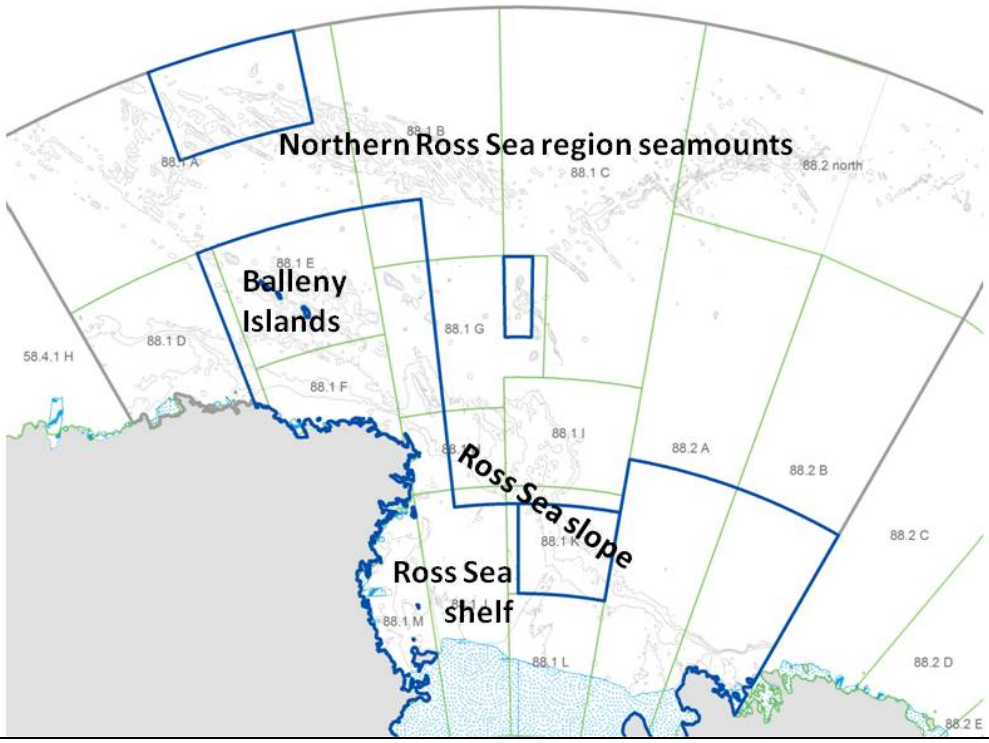

Figure 1. The Ross Sea region, showing geographic area categories into which research priorities are organized in the draft Ross Sea region MPA research and monitoring plan (SC-CAMLR-IM-I-BG/03-Rev1).

Summary

On this basis, research is planned or already underway to address a substantial portion of the priority research activities identified in the draft research and monitoring plan for the Ross Sea region described in SC-CAMLR-IM-I-BG/03-Rev1, even considering only thelimited number of new research projects described in this document or from papers submitted to CCAMLR scientific working groups in the past year. Specifically, the science referred to here is addressing or will address:

- 10 of 11 priority research activities identified for the Ross Sea shelf,
- 4 of 6 activities identified for the Ross Sea slope,
- 2 of 6 activities identified for the Balleny Islands and vicinity
- 1 of 5 activities identified for the Northern Ross Sea region and seamounts; and
- 2 of 4 activities identified for 'all areas'

Research listed here addresses 10 of 10 identified protection objectives for the Ross Sea region MPA.

Because only a subset of new and ongoing research activities by CCAMLR Members are included in this document, it is highly likely that the coverage of research priorities is even greater than listed here. Other new and ongoing research activities already being planned or conducted at this time by other CCAMLR Members will likely mean that this list can be expanded. We conclude that the draft research and monitoring plan described in SC-CAMLR-IM-I-BG/03-Rev1, while ambitious, is not unrealistic if CCAMLR Members continue to communicate their research and seek collaborative research partnerships with other Members. We encourage all interested Members to contribute to this list, perhaps during the course of CCAMLR XXXIII; this document can be updated as a Rev1 to provide a more comprehensive summary of new and planned research activities.

We also encourage Members with an active research interest in particular projects or objectives to contribute to this research wherever possible, and to approach other engaged Member countries or research institutions to seek and offer formal research partnerships and collaborative arrangements, toward achievement of a genuinely multi-Member ecosystem research and monitoring programme in the Ross Sea region.

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