COMMISSION FOR THE CONSERVATION
OF ANTARCTIC MARINE LIVING RESOURCES

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Chronology of previously submitted scientific documents, and updated maps and analyses supporting MPA planning in the Ross Sea region

Delegations of New Zealand and the USA

* This version contains a revision to Figure 10.

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Abstract

A proposal for a Marine Protected Area in the Ross Sea region has been submitted to CCAMLR and iteratively updated since 2012 consistent with Scientific Committee advice. The purpose of this paper is to: 1) identify previously submitted scientific documents supporting MPA planning in the Ross Sea region; 2) highlight relevant Scientific Committee advice to support or modify previous iterations of this proposal; and 3) update relevant maps, figures and analyses from previously submitted scientific papers to reflect the boundaries of the current MPA proposal and with updated fishery data, to assist evaluation of the current proposal.

Background

Since 2010 New Zealand and the United States have submitted several scientific documents to SC-CAMLR and its Working Groups to support the design and designation of a Marine Protected Area in the Ross Sea region. A corresponding formal MPA proposal was first submitted jointly by New Zealand and the USA to the Commission in 2012, and has been iteratively updated since that time, including changed boundaries, consistent with Scientific Committee advice and to reflect the views of other CCAMLR Members. Throughout this process New Zealand and the USA have continued to provide new analyses and supplemental scientific information in support of the proposed MPA. As a consequence, while the underlying science supporting the MPA is unchanged, many of the figures and analyses contained in previous scientific papers reviewed by CCAMLR are no longer current, because they depict or refer to previous iterations of the proposal (the boundaries of which have subsequently changed).

In 2014 WG-EMM agreed that documents supporting MPA planning and proposals should be assembled and made available on the CCAMLR website for each MPA planning domain, and that after designation of an MPA, relevant information from the supporting documents should be assembled to form an 'MPA Report' (WG-EMM-14 paragraphs 3.65-3.67). We note that for the Ross Sea region, while these supporting documents are freely available to the CCAMLR Membership and the scientific rationale is unchanged, the maps and quantitative analyses contained therein may be as much as three years out of date.

The purpose of this paper is to:

1) identify previously submitted scientific papers and analyses supporting MPA planning in the Ross Sea region;
2) highlight relevant Scientific Committee advice to support or modify previous iterations of the Ross Sea region MPA proposal; and
3) update relevant maps, figures and analyses from previously submitted scientific papers to reflect the boundaries of the current MPA proposal and with updated fishery data, to assist evaluation of the current proposal

Ross Sea region MPA supporting documents and corresponding advice

In 2014 WG-EMM agreed the following:

> For documents supporting MPA planning and proposals, the Working Group agreed that these could include: (i) documents providing background information (e.g. ecological descriptions of the planning domain), (ii) descriptions of spatial data used in the planning process, (iii) methodological descriptions of approaches to designing MPA scenarios, and (iv) documents containing or describing the MPA proposals. Information contained in all of these reference documents would then form the basis of future MPA Reports (WG-EMM-14 paragraph 3.66).

Consistent with this framework we identify below the previously submitted documents supporting the Ross Sea region MPA planning process, all of which remain available to the CCAMLR Membership to assist evaluation of the current proposal, except with reference to the updated Figures provided below. In the future these documents and updated figures may also form the basis for compilation of a MPA Report for the Ross Sea region.

Ecological background (i) and descriptions of spatial data used in the planning process (ii)

Consistent with points (i) and (ii) above, in 2010 the United States and New Zealand submitted the following documents for review by WG-EMM.

- WG-EMM-10/11 (Ainley et al. 2010) presented the outputs of an extensive international workshop held in Fairfax Virginia in 2009 to map and characterise the Ross Sea, including in-depth descriptions of the geological and oceanographic setting, seasonal ice dynamics, recent climatic and oceanographic trends, and biological data assembled from decades of Ross Sea research indicative of the spatial distributions and functional ecological roles of extant biodiversity across all trophic levels from phytoplankton to top predators. This paper included more than 40 figures, from which the relevant spatial data were made available in electronic format to guide MPA planning within CCAMLR.

- WG-EMM-10/30 (Sharp et al. 2010) presented the outputs of an international workshop held in Wellington, New Zealand in 2009 to select, compile and synthesize relevant spatial information necessary to inform MPA planning. Workshop outputs described in the paper included; i) separate benthic and pelagic bioregionalisations of the Ross Sea region (i.e. habitat classifications based on physical proxies for biological patterns), and ii) twenty-seven mapped ecological processes or biological distributions defining 'priority areas' to guide marine spatial planning in the Ross Sea region (drawing heavily on data described and made available in WG-EMM-10/11, above). These bioregionalisations and mapped priority areas were made available in electronic form for peer review by other CCAMLR Members and to inform the subsequent design of MPA scenarios (below).

- WG-EMM-10/12 (Ballard et al. 2010) presented the results of spatial environmental modelling of top predator distributions, to identify areas of particular ecological importance for inclusion in MPAs.

In 2010 WG-EMM reviewed these submissions (paragraphs 3.82-3.100) and agreed that a synthesis of these efforts in 2011 would be expected to support a comprehensive and effective spatial management plan to achieve CCAMLR objectives (paragraph 3.101).

Methodological descriptions of approaches to designing MPA scenarios (iii)

Consistent with point (iii) above (and heeding WG-EMM advice to synthesise their respective efforts) in 2011 and 2012 New Zealand and the United States submitted the following documents:

- WS-MPA-11/25 (Sharp and Watters 2011) described collaborative scientific efforts, and separate but complementary policy processes by the USA and New Zealand, to define protection objectives and design corresponding MPA scenarios also considering sustainable fishing. The USA process defined three protection objectives and involved extensive consultation with scientific and non-government stakeholders, and an analysis of the relative benefits of protecting different locations relative to the corresponding level of displacement of fishing effort. The NZ process defined eight protection objectives, made up of twenty-seven specific mapped priority areas for protection (as previously defined in Sharp et al. 2010 but updated following peer review by the principle authors of Ainley et al. 2010). New Zealand applied a Systematic Conservation Planning method in which quantitative protection targets were defined for each priority area (reflecting their relative ecological importance and the level of threat from fishing to each specific objective); an optimisation process sought to maximise protection of each priority area while minimising associated displacement of fishing effort.

- SC-CAMLR-XXX/9 (Delegation of the USA 2011) summarized the USA MPA planning process and scenario previously described in WS-MPA-11/25.

- SC-CAMLR-XXX/10 (Delegation of New Zealand 2011) summarised the New Zealand MPA planning process and scenario previously described in WS-MPA-11/25.

- WS-MPA-12/56 (Sharp and Ollivier 2012) described the GIS-based spatial planning tool used by New Zealand and the USA to aid the development and transparent evaluation of MPA scenarios with reference to spatially explicit protection objectives and cost layers.

The MPA planning methods utilised by New Zealand and the USA were consistent with existing Scientific Committee advice (see SC-CAMLR XXIX paragraphs 5.20, 5.22(ii), 5.34), and were favourably reviewed by the CCAMLR MPA workshop (see SC-CAMLR-XXX/6, paragraphs 2.44, 3.41, 5.4, and Appendix D), and the Scientific Committee (SC-CAMLR-XXX paragraphs 5.30-5.43).

Documents describing MPA proposals (iv)

Beginning in 2012, New Zealand and the USA resolved differences between two separate proposals and submitted a joint proposal for an MPA in the Ross Sea region. This joint proposal has been iteratively updated as follows.

- CCAMLR-XXXI/16-Rev1 (Delegations of New Zealand and USA 2012) presented a joint proposal in which protection objectives originally and separately proposed by New Zealand and the USA were merged, yielding ten objectives with twenty-eight associated priority areas for protection. [Note that beginning with this proposal and in subsequent iterations the numbering of protection objectives and specific priority areas are unchanged (i.e. as appear in Table 1 below)]. This proposal also introduced: i) the Special Research Zone (SRZ) on the Ross Sea slope to provide a lightly fished reference area to better understand the ecosystem effects of fishing and climate change while maintaining the continuity and integrity of the toothfish tagging programme; and ii) the Spawning Protection Zone in the northwest Ross Sea region, to provide seasonal protection to toothfish that were presumed to spawn in this area.

- CCAMLR-SM-II/04 (Delegations of New Zealand and the USA 2013c) presented the same substantive joint proposal as in 2012, but this time also for consideration by the Scientific Committee.

Based on the July 2013 proposal the Scientific Committee (SC-CCAMLR-IM-I) agreed the following: it supported the designation of an MPA on the Ross Sea shelf and in the area of the Balleny Islands, and pelagic protection in the southeast Ross Sea region (paragraph 2.31 i, iii); it provided specific guidance regarding spatial design of catch limits on the Ross Sea slope to achieve the goals of the Special Research Zone (paragraph 2.31 ii,iv,v); and it supported protection of a reduced area around Scott Seamount (paragraph 2.31 vi). However it did not support the toothfish spawning protection objective for the northern seamounts (paragraphs 2.31(vii), 2.32), instead supporting a lower level of representative protection for seamount benthic habitats in this area (paragraph 2.33).

- CCAMLR-XXXII/27 (Delegations of New Zealand and the USA 2013d) presented a modified proposal reflecting the above advice of the Scientific Committee. In the updated proposal; i) the protection objective related to toothfish spawning was eliminated and the area proposed for protection in the northern Ross Sea region was greatly reduced; ii) the area proposed for protection around Scott Seamount was reduced; and iii) the proposed mechanism to establish catch limits in the SRZ was modified.

Scientific Committee discussions regarding the October 2013 proposal are summarized in SC-CCAMLR-XXXII (paragraphs 5.45-5.49). Some Members felt that the proposal could be supported without modification, while others indicated a desire to see additional changes, for example to the proposed boundaries in the area of the northern seamounts (paragraph 5.45(i)), and to the proposed design and level of toothfish catches in the area of the SRZ and elsewhere on the Ross Sea slope (paragraph 5.45(ii-iii)).

Other supporting scientific submissions

The following additional papers were submitted to SC-CCAMLR-IM-I in July 2013.

- SC-CAMLR-IM-I/08 (Delegations of the USA and New Zealand 2013) summarised the scientific information available to CCAMLR that was judged to be either relevant to or in support of the Ross Sea region MPA proposal (i.e. including non-MPA and fishery-related papers). The information was summarised geographically into four main ecological regions: the Ross Sea shelf and coastal areas; the continental slope; the Balleny Islands and vicinity, and the Northern Ross Sea region including seamounts in the Pacific Antarctic Ridge.

- SC-CAMLR-IM-I-BG/02 (Delegation of New Zealand 2013) characterised current and historical data pertaining to the toothfish fishery in SSRU 88.1K, to inform discussions about the appropriate design and control of research fishing in the Special Research Zone (SRZ).

- SC-CAMLR-IM-I/09 (Delegations of New Zealand and the USA 2013a) described an analysis of likely or potential threats from fishing to the achievement of MPA objectives, including potential ecosystem effects of the existing toothfish fishery or of future fisheries targeting other species. The paper described how under the Systematic Conservation Planning framework, quantitative protection targets for each specific objective and priority area were chosen to reflect the likelihood and severity of the associated potential threat from fishing, to ensure that the most significant threats were most strongly mitigated by displacing fishing effort out of the area in which ecosystem effects were most likely and into areas where fishing is thought to be less risky.

The threats analysis was submitted in response to specific requests by other Members (i.e. SC-CAMLR-XXX/6 paragraph 3.41, SC-CAMLR XXX, paragraph 5.37, SC-CAMLR XXXI, paragraph 5.36). The Scientific Committee had previously agreed that analysis of the extent to which current or future activities may threaten the objectives of the MPA was a valid scientific question to inform the design and/or management of MPAs (SC-CAMLR XXXI, paragraph 5.37). Scientific Committee discussion of these documents is reflected in SC-CAMLR-IM-I paragraphs 2.2 – 2.8.

Research and Monitoring Plan

As required in CM 91-04, Annex C of the draft Conservation Measure describing the proposed MPA for the Ross Sea region includes the priority elements of a Research and Monitoring plan (i.e. in Annex C). In addition, consistent with Scientific Committee advice and the expressed views of other CCAMLR Members, New Zealand and the United States have submitted the following documents toward the development of a full Research and Monitoring plan to accompany a Ross Sea region MPA.

- WG-EMM-12/46 (Watters and Reiss 2012) presented a draft Research and Monitoring plan prepared by the United States.
- WG-EMM-12/57 (Pinkerton and Sharp 2012) presented a draft Research and Monitoring plan prepared by New Zealand.
- SC-CAMLR-IM-I-BG/03-Rev1 (Delegations of New Zealand and the USA 2013) presented a synthesis of both of these draft Research and Monitoring plans, re-organised to conform with the advice of WG-EMM-14 (paragraph 3.43).

In 2013 the Scientific Committee commented that the proposed draft research and monitoring plan is still ambitious (SC-CAMLR-XXXII paragraph 5.45(v)). In the supplemental background paper submitted to the current meeting (SC-CAMLR-XXXIII-BG-xx) we focus on describing aspects of the plan that are already being delivered or for which new research projects or international collaborations have been initiated since the submission of SC-CAMLR-IM-I-BG/03-Rev1 in 2013. New Zealand and the United States encourage other interested Members to contribute to this document of prepare similar submissions describing new or ongoing research programmes in the Ross Sea region, to contribute to establishing a truly multi-national research and monitoring programme to support a Ross Sea region MPA.

Updated analyses, maps and figures to reflect the current MPA proposal

CCAMLR XXXIII/21 identifies ten specific objectives for the Ross Sea region MPA, as follows, and 25 associated mapped areas of priority for inclusion in the MPA to achieve these objectives (Table 1, below).

i. to conserve ecological structure and function throughout the Ross Sea Region at all levels of biological organization, by protecting habitats that are important to native mammals, birds, fishes, and invertebrates;

ii. to provide a reference area in which fishing is limited, to better gauge the ecosystem effects of climate change and fishing, and to provide other opportunities for better understanding the Antarctic marine ecosystem;

iii. to promote research and other scientific activities (including monitoring) focused on marine living resources.

iv. to protect a representative portion of benthic and pelagic marine environments;

v. to protect large-scale ecosystem processes responsible for the productivity and functional integrity of the ecosystem;

vi. to protect core distributions of trophically dominant pelagic prey species;

vii. to protect core foraging areas for land-based predators or those that may experience direct trophic competition from fisheries;

viii. to protect coastal locations of particular ecological importance;

ix. to protect areas of importance in the life cycle of Antarctic toothfish; and

x. to protect known rare or vulnerable benthic habitats."

Protection achieved and fishing displacement under the current 2014 MPA proposal

As described in SC-IM-I/09, MPA objectives fit into one of three main categories as follows: *representativeness* (objective iv), *mitigating ecosystem threats* (objectives v – x), and *scientific reference areas* (objective ii). (Note that objective i integrates multiple threat-based objectives (v-x) and objective iii applies at all locations inside the MPA; therefore, these objectives do not appear in Table 1.)

Table 1 summarizes the level of protection sought for priority feature or areas relevant to specific objectives of the proposed MPA. These 'protection targets' were chosen as a function of the size and ecological importance of each feature or area and the level of potential threat from fishing. The right-hand column indicates the nature of plausible threats to each priority feature or area, classified as follows:

A. Direct impact by existing toothfish fishery
B. Plausible direct trophic interaction (competition for prey, or predation release) with existing toothfish fishery
C. Direct impact by potential future krill fishery
D. Plausible direct trophic interaction (competition for prey) with potential future krill fishery

Table 1 also shows the actual level of protection achieved within the proposed MPA for each specific priority area; these numbers have been updated to reflect current proposed MPA boundaries in CCAMLR-XXXIII/21.

The analysis in Table 1 was first presented in Sharp and Watters (2011) and again in association with the 2013 MPA proposal (SC-CAMLR-IM-I/09). In the updated analysis below, examination of protection levels achieved relative to protection sought for each specific objective and priority area, in comparison with previous iterations, reveals that the changes to the proposed MPA boundaries over the past 3 years are consistent with Scientific Committee advice and the application of the Systematic Conservation Planning framework. High levels of protection are achieved for those objectives with high protection targets that were endorsed by the Scientific Committee in 2013 (SC-CAMLR-IM-I paragraph 2.31). Where the size of the MPA has been reduced (primarily in the north) this reflects 1) the Scientific Committee's view that the protection objective for toothfish spawning areas (9d and 9e) was not sufficiently supported by available data (SC-CAMLR-IM-I paragraph 2.32), and 2) application of a generally lower 'representativeness' protection target for benthic bioregions, reflecting Member comments (see SC-CAMLR-XXX paragraph 5.41, SC-CAMLR-IM-I paragraphs 2.67, 2.69).

The analysis of fishing effort displacement by the MPA in the existing toothfish fishery (as a metric of 'cost' of the MPA) was first presented in Sharp and Watters (2011) but is updated here incorporating an additional three years' fishing data. The metric for 'total catch, 2009-2013' (in tons) best represents the expected magnitude of the effect of the proposed MPA on the actual operation of the fishery, relative to status quo management. (Note that because the SRZ catch limit mechanism is defined in terms of catch rather than effort, it is no longer possible to estimate displacement including the effect of the SRZ using an effort based metric). The metric for 'location-specific CPUE' (as a proxy for patterns of toothfish abundance) estimates the proportion of the toothfish stock that would occur inside the MPA (but not including the SRZ), with implications for stock assessment.

Table 1: Protection objectives and associated mapped areas or features of priority for protection (spatial distributions as shown in Figures 2-10), and levels of protection sought for each area. Protection levels achieved under the 2014 Ross Sea region MPA proposal, and the nature of plausible fishery interactions are also identified for each priority feature or area (see text).

Priority feature or area and figure where shown		Description and boundary of priority feature or area	Region	Protection sought	% of priority area inside MPA	Potential threat from fishing
Objective ii: scientific reference areas comparing fished vs lightly- or un-fished areas						
	Fig 2	Iselin and Mawson Banks vs. Special Research Zone	slope north	fished vs. un-fished	N/A	N/A
Objective iv: representativeness of benthic and pelagic environments						
	Fig 3	Benthic bioregionalisation	N/A	Low (each	min. 17%	N/A
	Fig 4	Pelagic bioregionalisation	N/A	bioregion)	min. 1%	N/A
Objective v : large-scale ecosystem processes/ areas						
a	Fig 5a	Ross Sea shelf front intersection with seasonal ice	slope	medium	67%	D
b	Fig 5b	Polar Front*	north	low	20%	*
c	Fig 5c	Balleny Islands and proximity	Balleny Is	very high	99%	A,B,C,D
d	Fig 5d	Ross Sea polynya Marginal Ice Zone	shelf	medium	88%	D
e	Fig 5e	Eastern Ross Sea multi-year ice	slope	high	99%	D
Objective vi: trophically dominant pelagic prey species						
a	Fig 6a	Antarctic krill core distribution	slope	medium	55%	C
b	Fig 6b	Crystal krill core distribution	shelf	high	99%	C,D
c	Fig 6c	Antarctic silverfish core distribution	shelf	high	98%	B,D
Objective vii: key top predator foraging distributions						
a	Fig 7a	Adélie penguin summer core foraging distribution	shelf	high	92%	D
b	Fig 7b	Emperor penguin summer core foraging distribution	shelf	high	94%	D
c	Fig 7c	Weddell seal summer core foraging distribution*	shelf	very high	96%	B
d	Fig 7d	Type C killer whale core summer foraging distribution*	shelf	very high	83%	B
Objective viii: coastal/localized areas of particular ecosystem importance						
a	Fig 8a	Southern Ross Sea shelf persistent winter polynya	shelf	high	100%	B,D
b	Fig 8b	Coastal polynyas	shelf	very high	94%	B,D
c	Fig 8c	Terra Nova Bay	shelf	very high	100%	A,B,C,D
d	Fig 8d	Victoria coast – coastal buffer and platelet ice formation	shelf	very high	100%	A,B,D
e	Fig 8e	Pennell Bank polynya	shelf	high	74%	B,D
Objective ix: D. mawsoni life cycle areas						
a	Fig 9a	Sub-adult toothfish settlement areas on the Ross Sea shelf*	shelf	very high	100%	A,B
b	Fig 9b	Dispersal trenches for maturing toothfish*	shelf	very high	81%	A,B
c	Fig 9c	Adult feeding areas on the Ross Sea continental slope*	slope	medium	32%	A
~~d~~	~~N/A~~	~~Northern spawning areas west of Ross Gyre divergence~~	~~north~~	~~N/A~~	~~N/A~~	~~A~~
~~e~~	~~N/A~~	~~Northern spawning east west of Ross Gyre divergence~~	~~north~~	~~N/A~~	~~N/A~~	~~A~~
*Objective x: rare or vulnerable benthic habitats**						
a	Fig 10a	Balleny Islands and adjacent seamounts	Balleny Is	high	100%	A
b	Fig 10b	Admiralty Seamount	north	very high	100%	A
c	Fig 10c	Cape Adare proximity continental slope	slope	high	100%	A
d	Fig 10d	Southeast Ross Sea continental slope	slope	high	100%	A
e	Fig 10e	Southern McMurdo Sound	shelf	very high	100%	A
f	Fig 10f	Scott Seamount	North	very high	100%	A

Cost metric	Description of fishing effort displacement metric	% displacement
length	Total catch (tons), 2009-2013	29%**
catch	location-specific CPUE (tons/set)	34%

* note protection totals for toothfish life cycle areas and toothfish predators do not include the contribution of the SRZ

** note fishing effort displacement totals assume annual catches of 300 tons inside the SRZ

Updated Figures depicting priority features and areas for protection in association with specific objectives

CAMLR-XXXIII/21 Annex B identifies the specific objectives of the proposed MPA, and for threat-based Objectives v – x, identifies the corresponding mapped areas of priority for protection in order to achieve each objective. The means by which these spatial distributions were defined and the source data utilised are described in Sharp et al. (2010); some distributions were subsequently modified following peer review as described in Sharp and Watters (2011). The rationale for choosing which distributions to use in MPA planning and the priority assigned to each is described more fully in SC-CAMLR-IM-I/09. The distributions are unchanged since 2011 and have been made available to the CCAMLR Membership throughout the Systematic Conservation Planning process; however the Figures in which these maps most recently appeared (in Sharp and Watters 2011) are now misleading, because they depict also the proposed MPA boundaries at that time (which have since changed) and because the numbering of the objectives themselves has changed. Figures depicting these distributions are updated here for ease of reference, superimposing the current proposed MPA boundaries. For clarity, Figure and priority area numbers are harmonised with the numbering of specific objectives in CAMLR-XXXIII/21 Annex B (roman numerals designate protection objectives, standard numerals designate corresponding priority areas).

Objective i integrates all threat-based objectives v – x; all corresponding priority areas for protecion are superimposed in Figure 1. Objective ii designates a scientific reference area on the Ross Sea slope, shown in Figure 2. Objective iii applies at all locations inside the MPA and is not shown. Objective iv is for representativeness with respect to the bioregionalisations in Figures 3-4. Objectives v-x define threat-based objectives, within areas depicted in Figures 5-10.

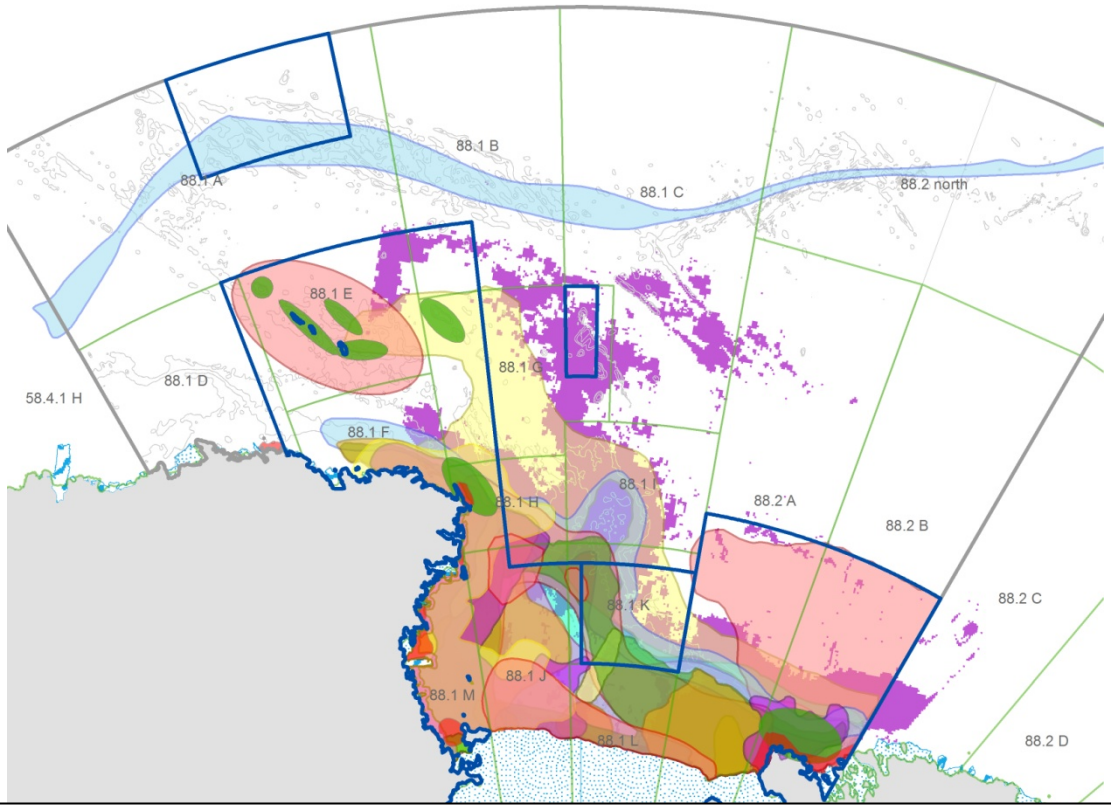

Figure 1 (objective i). Potential protection outcomes offered by the Ross Sea region MPA. Protection outcomes are mapped using all the priority areas illustrated in Figures 5-10 below, plus the outcomes of spatial habitat models in Ballard et al. (2010). To simplify the presentation, representativeness outcomes (i.e., Figures 3 and 4) are not illustrated. [updated from SC-CAMLR-IM-I/08]

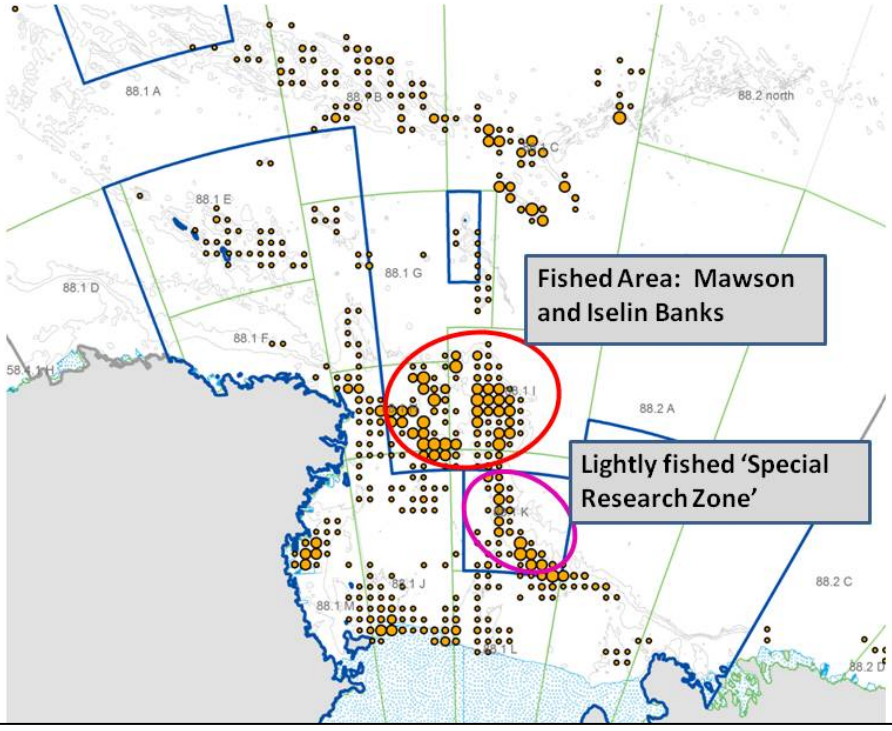

Figure 2 (objective ii). Potential science outcomes offered by establishment of a scientific reference area on the Ross Sea slope (objective ii). The designated areas overlaying the continental slope constitute a unique complex of bioregions (see Figure 4). The boundaries of the proposed MPA bisect this complex so that comparisons can be made between the area of the lightly fished Special Research Zone (SRZ, in purple) and the fully developed fishing ground over Mawson and Iselin Banks (red). Orange circles represent total historical toothfish removals (1998-2013). [updated from SC-CAMLR-IM-I/08]

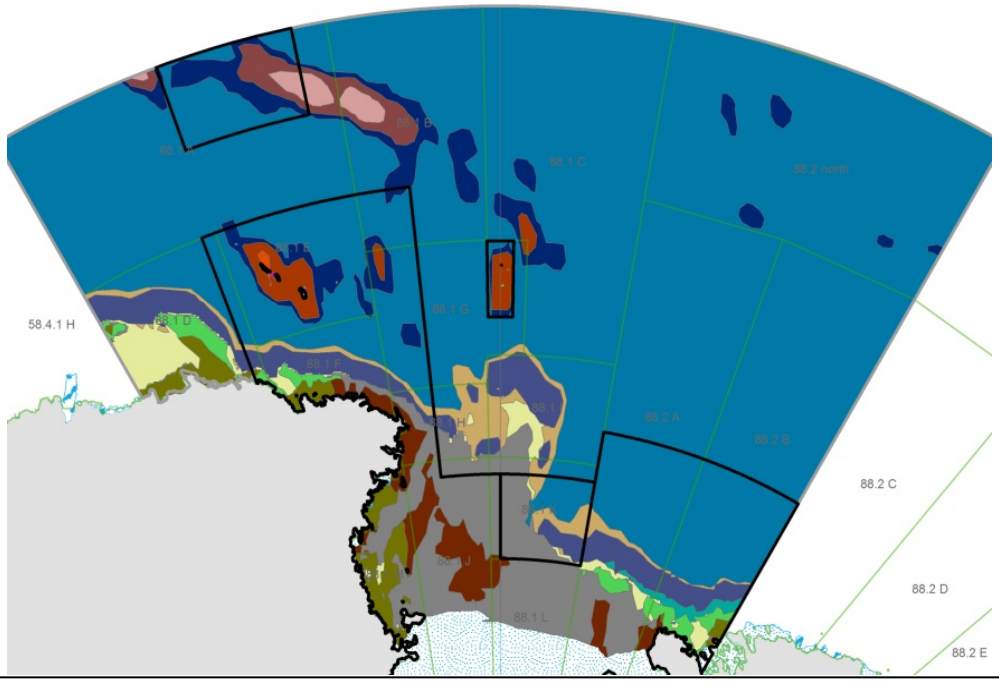

Figure 3 (objective iv): Benthic bioregionalisation of the Ross Sea region, with 17 benthic bioregions. [From Sharp et al. 2010].

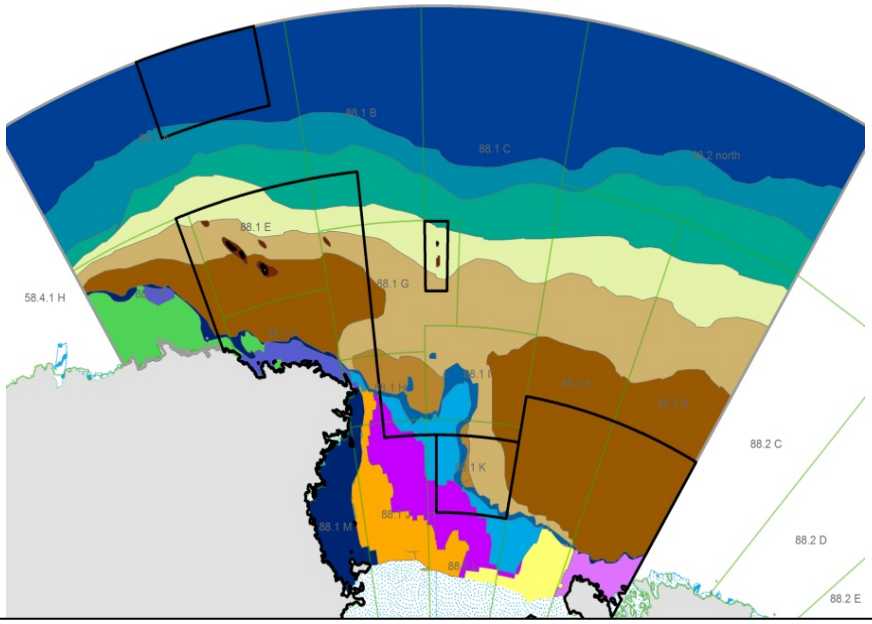

Figure 4 (objective iv): Pelagic bioregionalisation of the Ross Sea region, with 18 pelagic bioregions. [From Sharp et al. 2010].

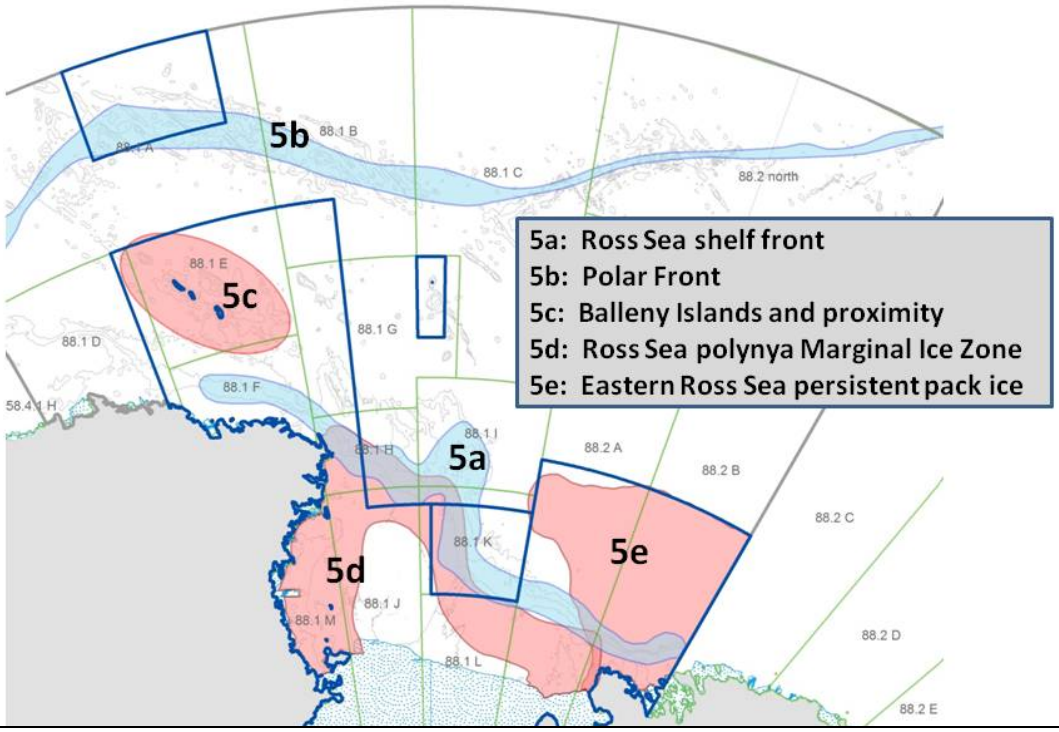

Figure 5 (objective v): Large-scale ecosystem processes or features of particular importance in association with fronts (blue) or ice dynamics (red). The summer ice-free continental shelf front (5a, blue) and the Ross Sea polynya Marginal Ice Zone (5d, red) are preferred foraging areas for top predators. The Polar Front (5b, blue) is targeted by flying seabirds. The Balleny Islands (5c, red) are an ecosystem hotspot. The eastern Ross Sea persistent pack ice zone (5e, red) is important for moulting seals and penguins. [From Sharp et al. 2010, modified as described in Sharp and Watters 2011]

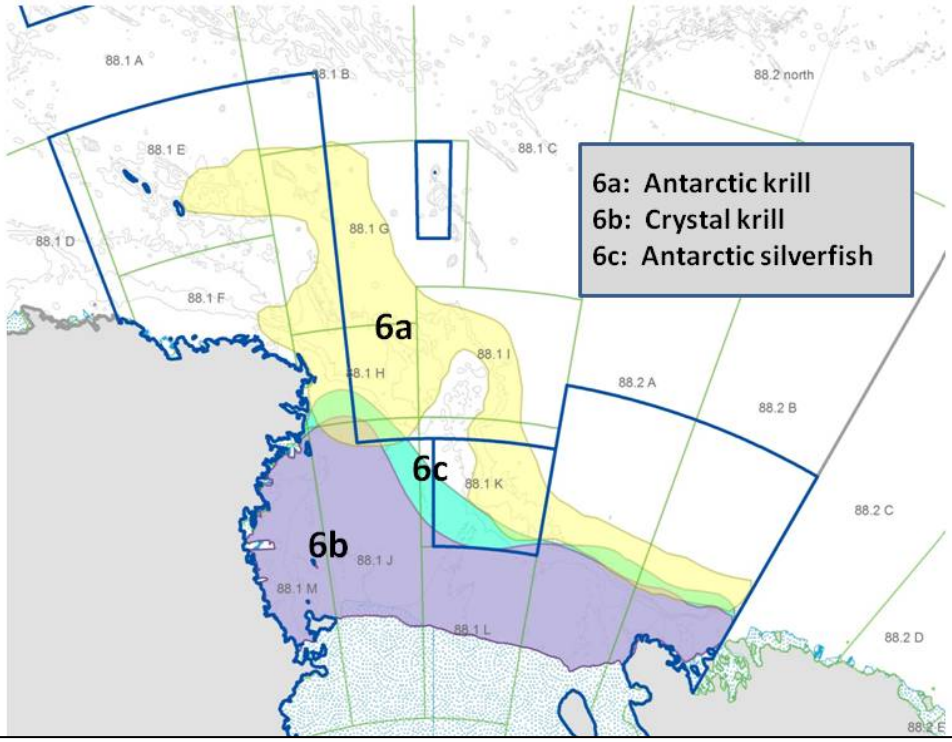

Figure 6 (objective vi): Core distributions of trophically dominant pelagic prey species supporting higher trophic levels: Antarctic krill (6a, yellow); crystal krill (6b, purple); and Antarctic silverfish (6c, turquoise). [From Sharp et al. 2010, modified as described in Sharp and Watters 2011]

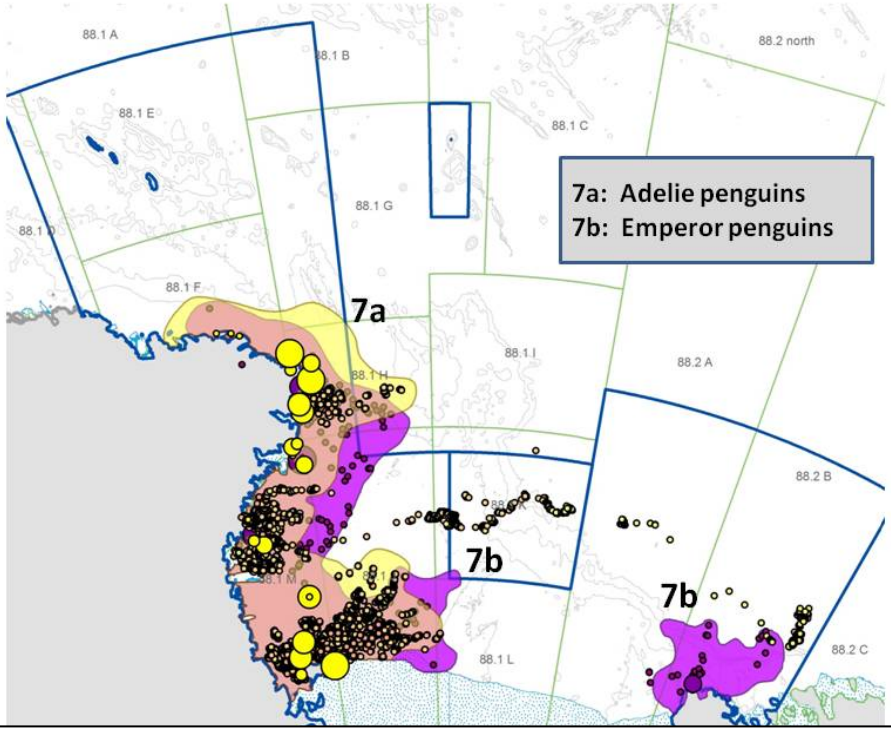

Figure 7ab (objective vii): Core breeding (summer) foraging areas for Adélie penguins (7a, yellow); and for Emperor penguins (7b, purple) including colony sizes and summer foraging tracks. [From Sharp et al. 2010; colonies and tracking data from Ainley et al. 2010]

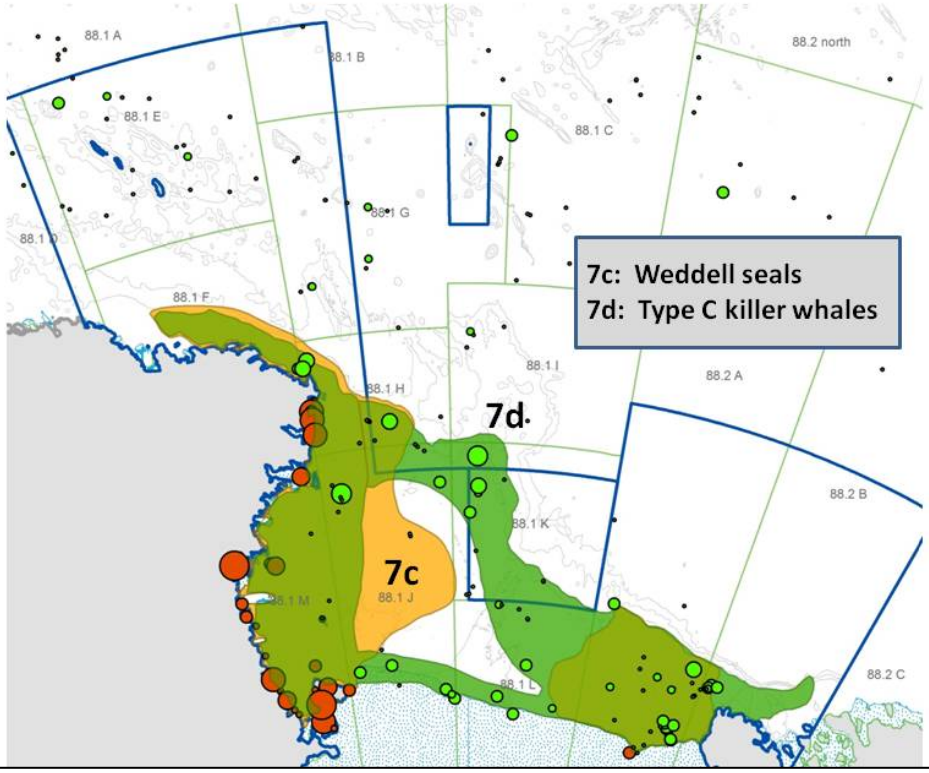

Figure 7cd (objective vii): Core foraging areas for Weddell seals (7c, orange) during the summer breeding, lactation, and post-weaning recovery phase, including breeding colony locations and sizes; and for Type C killer whales (7d, green) during summer including at-sea sightings. [From Sharp et al. 2010, modified as described in Sharp and Watters 2011; colonies and sightings data from Ainley et al. 2010]

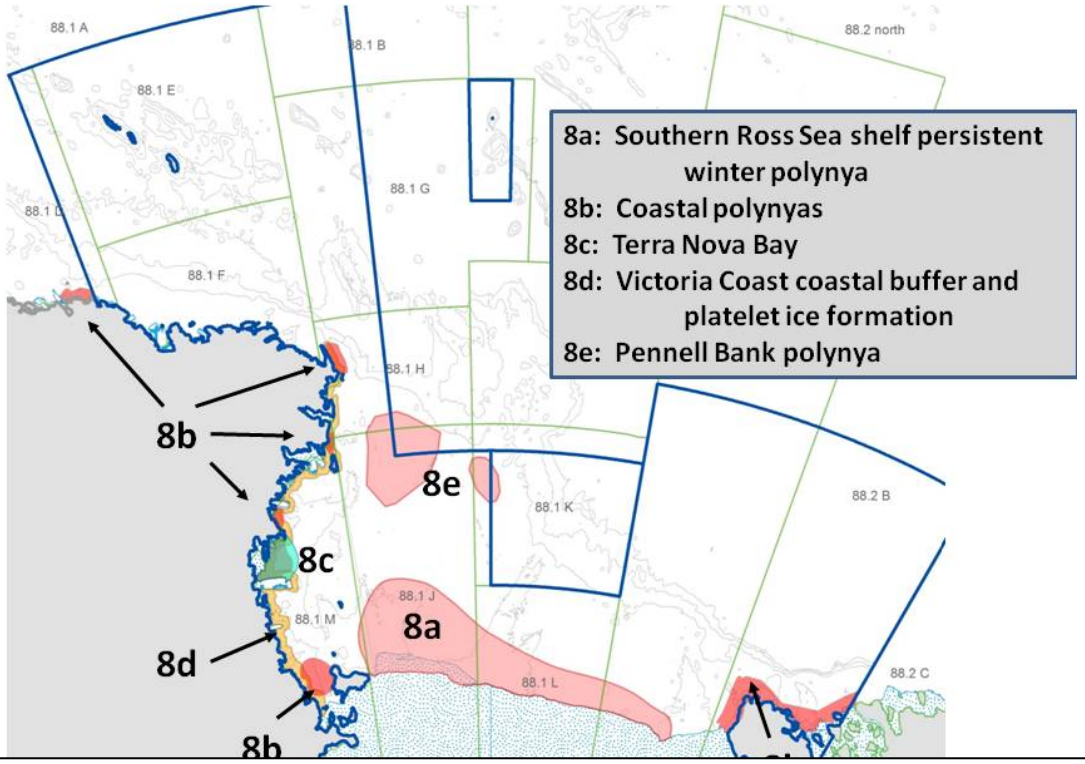

Figure 8 (objective viii). Coastal or localised areas of particular ecological importance to the Ross Sea shelf ecosystem. The Southern Ross sea persistent (winter) polynya (8a, red). Shallow coastal polynyas (8b, red). Terra Nova Bay (8c, turquoise). The Victoria Coast buffer and platelet ice formation zone (8d, orange). Pennel Bank polynya (8e, red). [From Sharp et al. 2010, modified as described in Sharp and Watters 2011]

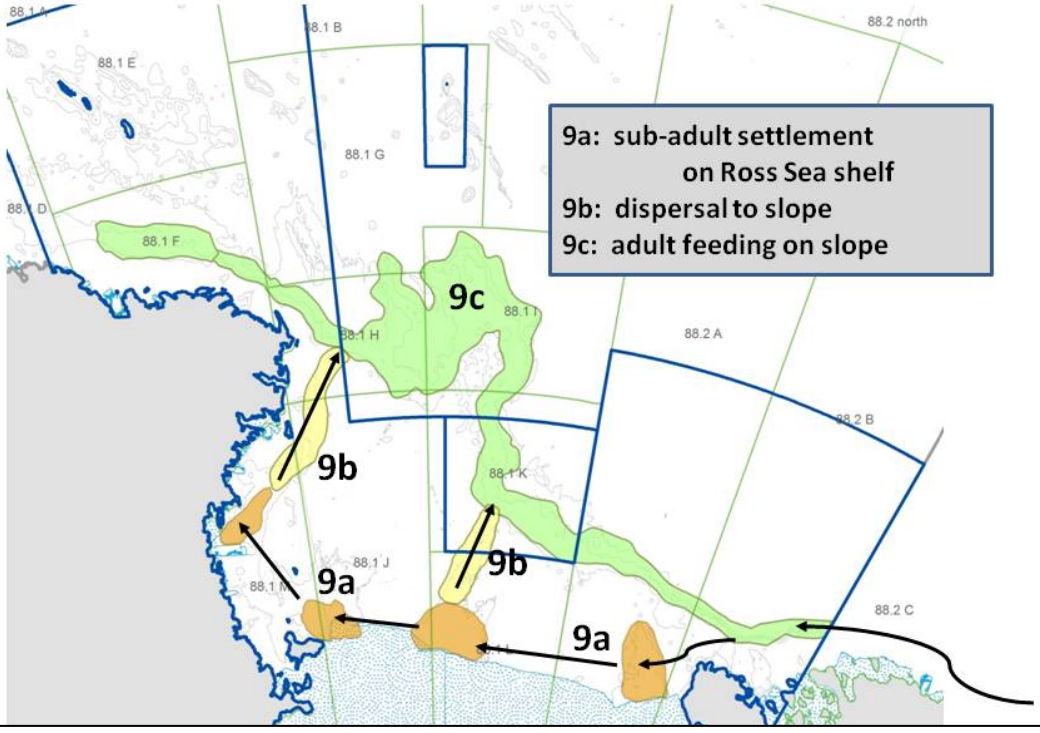

Figure 9 (objective ix): *D. Mawsoni* life cycle areas, following Hanchet et al. (2008), including: sub-adult settlement areas on the Ross Sea shelf (9a, orange); dispersal trenches for maturing toothfish (9b, yellow); adult feeding areas on the Ross Sea slope (9c, green). [From Sharp et al. 2010, modified as described in Sharp and Watters 2011] The Scientific Committee determined that the objective to protect presumed *D. Mawsoni* spawning areas in the northern Ross Sea region (9d and 9e) was not sufficiently supported by the data; these areas no longer appear.

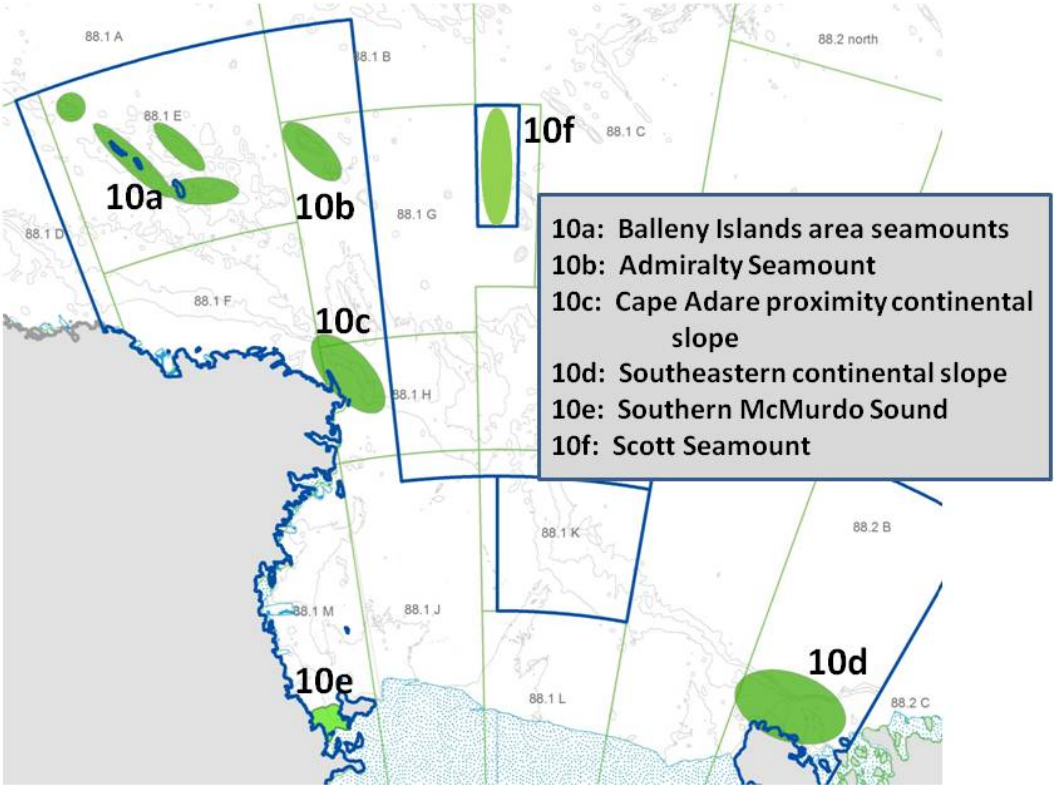

Figure 10 (objective x): Areas supporting known rare or vulnerable benthic habitats. 10a: Balleny Islands and vicinity seamounts; 10b: Admiralty seamount; 10d. Southeast Ross Sea continental slope; 10e: Southern McMurdo Sound. 10f: Scott Seamount [modified ~~F~~from Sharp et al. 2010]

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