

Ecosystem-Based Management of the Antarctic Krill Fishery to Protect Penguins and Other Krill Predators

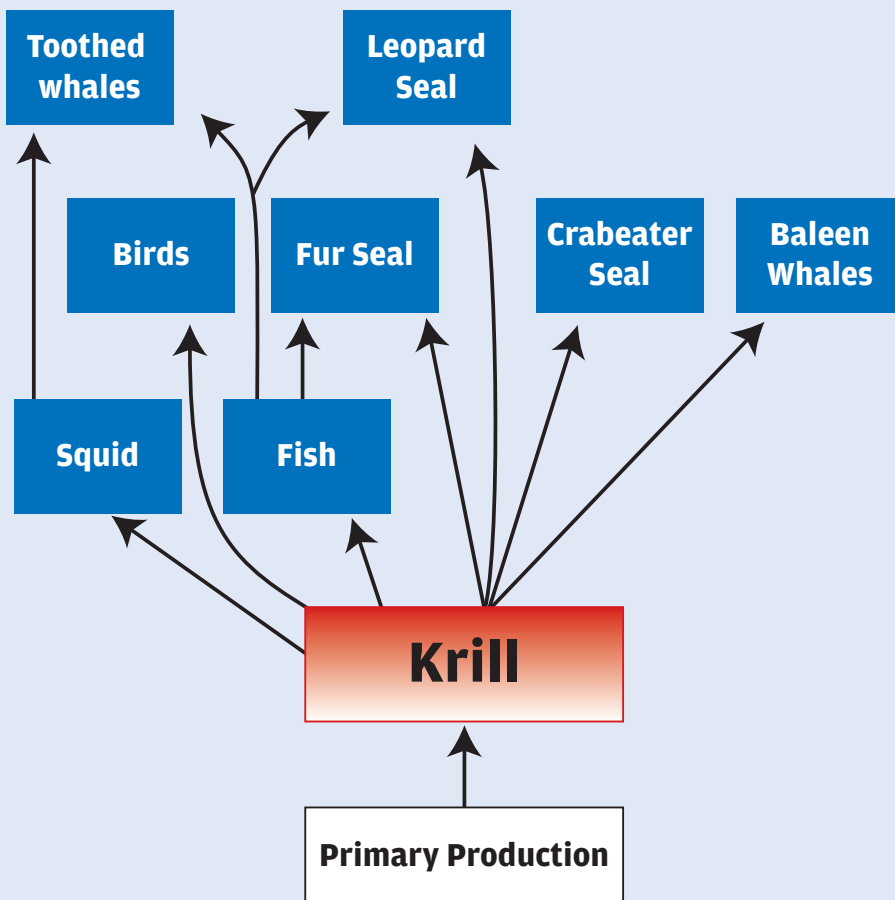


by Virginia Gascón González, Rodolfo Werner Kinkelin & Mark Stevens

1. Krill's central role in the Antarctic marine ecosystem

Antarctic krill (*Euphausia superba*), a widespread species with circumpolar distribution, is central to the Antarctic marine food web, as most organisms are either direct predators of krill or are just one trophic level removed.

Areas of highest krill concentration are often close to the land-based breeding colonies of penguins and seals. These predator colonies depend on nearby krill populations to feed and rear their offspring during the Antarctic summer.



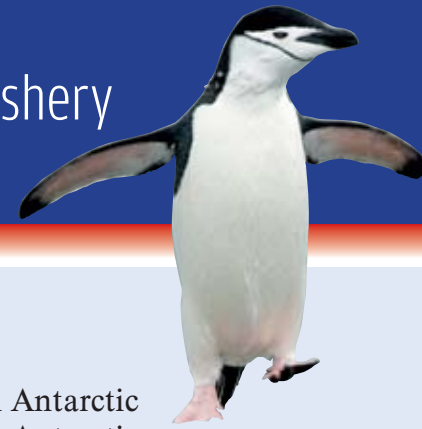
Simplified representation of the Southern Ocean food web linkages that are centred around krill.

Source: I. Everson, "Role of krill in marine food webs, the Southern Ocean," *Krill: Biology, Ecology and Fisheries*, (I. Everson, ed.) Fisheries and Aquatic Resources, Series 6, Oxford: Blackwell Science, 2000.



ANTARCTIC
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2. Climate change effects on krill

The climate in Antarctica is warming rapidly, especially around the Western Antarctic Peninsula, which acts as a major spawning nursery and recruitment area for Antarctic krill. This warming results in reduced extent and duration of seasonal sea ice, which in turn impacts krill recruitment and puts krill availability for predators in jeopardy. This is because krill are tightly coupled with the marginal ice-edge zone to forage on sea ice algae in summer and winter, and juvenile krill rely on under ice habitat for over-wintering and as a refuge from predators.



Chinstrap Penguins are thought to be vulnerable to variations in krill availability due to climate forces.

Photo: ©Flavio Quintana.

3. Antarctic penguins: krill-dependent predators especially vulnerable to changes in krill availability

Adelie (*Pygoscelis adeliae*); Chinstrap (*Pygoscelis antarctica*); Macaroni (*Eudyptes chrysolophus*); and Gentoo penguins (*Pygoscelis papua*) are dependent to a great extent on Antarctic krill. Macaroni penguins are listed as vulnerable on IUCN's Red List of Threatened Species and gentoo penguins are categorised as near threatened.

In addition, individual colonies of other penguin species in Antarctica may be of concern despite not being included in the IUCN Red List. For example, analysis of long-term population data from both the South Shetland and South Orkney Islands has revealed consistent declines in both Adelie and chinstrap penguin numbers over the past 20 to 30 years. These population declines may reflect the influence of reduction in prey availability linked to large-scale climate forcing.



The Gentoo Penguin is near threatened, according to IUCN's Red List.

Photo: © Lyn Mayr.

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4. Fishing for krill: is the largest Southern Ocean fishery in competition with penguins?

The Southern Ocean contains the largest stocks of krill in the world. The Antarctic krill fishery has been the largest fishery in the Southern Ocean since the late 1970s and has prospects for becoming the largest global fishery.

Antarctic Krill fishing occurs entirely in the South West Atlantic, and is concentrated within 100 km of known breeding colonies of Adelie, gentoo, chinstrap and macaroni penguins. This implies a complete overlap between the area of fishing operations and the foraging ranges of these predators.

There is clear evidence that individual breeding populations of several penguin species are declining throughout the area where the krill fishery operates, likely as a result of reduced krill availability. While environmental forcing is thought to be the main driver for reduced krill populations, the combined effect of fishing and climate change is a concern.

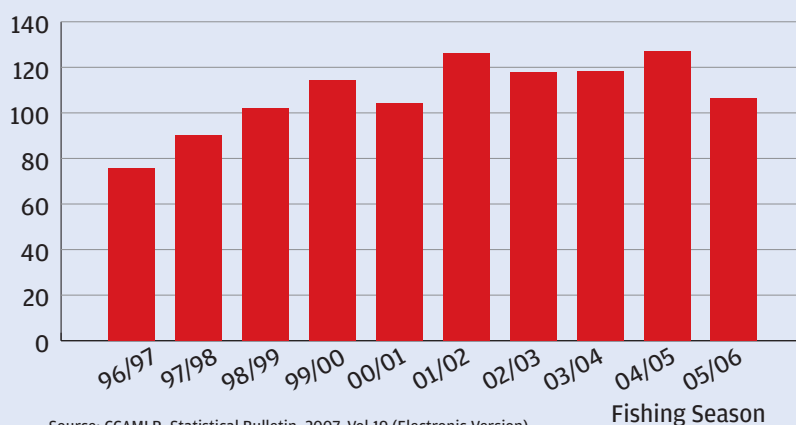
For the last three years, Antarctic krill catches have been stable around 120,000 tonnes, but an increasing trend is clearly observed. An expansion of this fishery seems imminent, due to the following main factors:

- Krill's increased demand as feed for the expanding international aquaculture industry due to krill's excellent value as nutrient source for high-value cultured fish like farmed salmon.
- Development of new high value markets such as pharmaceutical and dietary products.
- Development of modern catching and on-board production technologies that allow vessels to maximize catches and improve profitability. The application of these technologies to krill fishing in the Antarctic enables operators to increase catch up to 120,000 tonnes per year per vessel (equal to the total annual krill catch in recent years).

All these factors combined could bring the krill fishery to a six-fold increase in just one fishing season, with likely harmful effects on penguin colonies located close to main fishing grounds.



Evolution of Antarctic krill catches in the CCAMLR Area 1996-2006.



Source: CCAMLR, Statistical Bulletin, 2007, Vol 19 (Electronic Version)

Adelie penguin's reproductive performance in certain areas of the Antarctic is diminishing, likely in response to population biomass of krill falling close to or below the level required to support predator demand.

Photo: ©Flavio Quintana.

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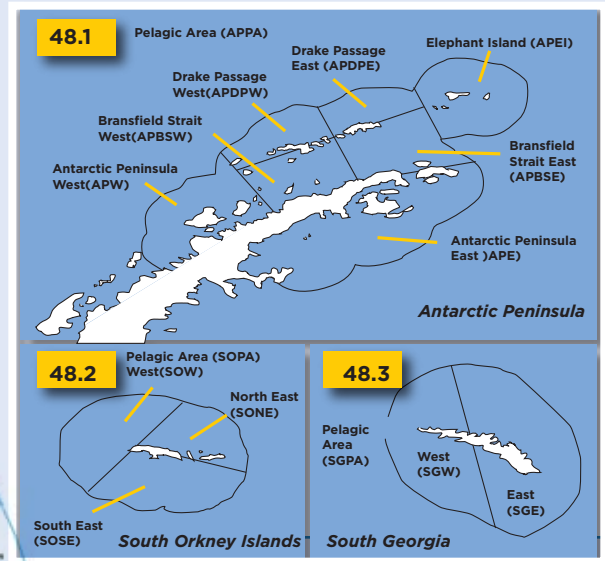
5. Management of the Antarctic krill fishery

Fishing for krill in the Antarctic is subject to the management regime established by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR). CCAMLR was a pioneer in endorsing an ecosystem approach to fisheries management, intended to maintain the ecological relationships between harvested, dependent and related populations of Antarctic marine living resources. CCAMLR also embraces the precautionary approach as one of its core conservation principles.

CCAMLR negotiations were prompted, in significant part, in response to the rapid expansion of the krill fishery in the 1970's and the related concerns over the possible impacts that krill fishing might have on the Antarctic marine environment. The extended distribution of krill was also a key factor in the designation of the management area for CCAMLR.

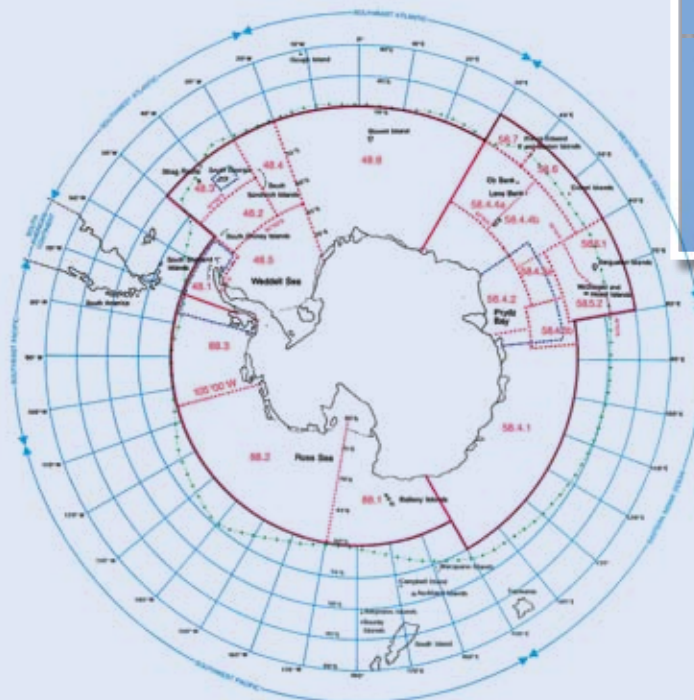
CCAMLR's ecosystem approach becomes especially relevant in the management of krill fishing. For example, in the South West Atlantic, catch limits incorporate a level of krill escapement of 75% of the pre-exploitation biomass, instead of the 50% level normally used in single-species management, in an attempt to account for the needs of krill-dependent predators. However, these catch limits apply to very large oceanic areas, failing to consider the potential for localised effects from fishing, since the interactions between krill, predators and the fishery occur at much smaller scales.

In 2002, to address concerns that localised intensive fishing might compromise the availability of krill for predators in certain areas, CCAMLR subdivided the South West Atlantic into 15 small units for the management of the krill fishery (Small-Scale Management Units or SSMUs). CCAMLR is now considering how the krill catch limit could be allocated among these SSMUs.



Map of the CCAMLR Area

- STATISTICAL AREA
- ZONE STATISTIQUE
- CLASSE STATISTIQUE PAYSAGE
- AREA STATISTICA
- STATISTICAL SUBAREA
- SOUS-ZONE STATISTIQUE
- CLASSE STATISTIQUE PAYSAGE SUBAREA
- SUBAREA STATISTICA
- ANTAKTIC CONSERVANCE
- COMMISSIONNE ANTAKTICQUE
- ANTAKTISKESSKAPSSAMRÞYÐING
- COMMISSIONNE ANTAKTICA
- CONTINENT, ISLAND
- CONTINENT, ÎLE
- SKAFTING, OYKUR
- CONTINENTE, ISLA
- BIRGJAFNARDISLENNIR
- ZONE STATISTIK
- PAYSAGE STATISTISKA
- REGIONER STATISTISKA



Location of SSMUs in the Southwest Atlantic. Bottom left, Subarea 48.1: Antarctic Peninsula; Bottom right, Subarea 48.2: South Orkney Islands; Top right, Subarea 48.3: South Georgia Islands.

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6. The importance of penguin research and monitoring for ecosystem-based management of fisheries in Antarctica

CCAMLR has established a program to monitor the health of top predator populations in the Antarctic ecosystem: the CCAMLR Ecosystem Monitoring Program (CEMP). This program was initiated in 1986 to detect significant changes to the ecosystem, particularly to krill predators, and to signal when such changes were the consequence of fishing. Fieldwork and data acquisition for the CEMP are voluntarily carried out by CCAMLR Member countries. The program is limited to just a few selected krill predators and is established in only a few areas.



The Adeli penguin (*Pygoscelis adeliae*) is greatly dependent on krill for food and is currently being monitored by CCAMLR's Ecosystem Monitoring Program

Photo: © Lyn Mayr.

7. Further steps in ecosystem-based management are needed to protect penguins and other Antarctic species

CCAMLR can become a model of the full application of ecosystem-based management. However, the implementation of the ecosystem approach to krill fisheries management is still at an incipient stage. For example, CCAMLR still needs to establish krill catch limits for small management units, so as to distribute the effort geographically in a way that avoids localised depletion of krill and minimises impacts on predator populations.

In order to account for the requirements of krill predators and the effects of climate change, a feedback management procedure needs to be implemented to allow management measures to be adjusted in response to ecosystem monitoring. Full development of a feedback management scheme will require expanding the CEMP (as monitoring data are currently not available for many of the areas that are regularly fished), obtaining better estimates of abundance and krill consumption rates of krill predators, and gaining more information on important aspects of krill biology and ecology.



Macaroni penguin
(*Eudyptes chrysolophus*)

Photo: © Ken Wright.