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MANAGEMENT OF THE ANTARCTIC KRILL: ENSURING THE CONSERVATION OF THE ANTARCTIC MARINE ECOSYSTEM

PRESENTED BY THE ANTARCTIC AND SOUTHERN OCEAN COALITION (ASOC)

The Antarctic and Southern Ocean Coalition

1. Introduction

Antarctic krill (*Euphausia superba* Dana) is central to the Antarctic marine food web, as most organisms are either direct predators of krill or are just one trophic level removed from krill. Traditional, single-species fisheries management principles are not applicable to the Antarctic krill fishery due to the key role of this species in the Southern Ocean food web. A multi-species management approach is necessary to take into account potential impacts on krill dependent predators and the Antarctic marine environment as a whole, in case of an expansion of the krill fishery. The *Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR)* has developed an "ecosystem approach" which represents an important step forward with regards to fisheries management, both scientifically and politically.

Although krill catches in the Southern Ocean are currently well below CCAMLR catch limits, there is potential for a rapid expansion of the fishery in future years, as krill-processing technology develops and demand for krill products increases. The potential for a rapid expansion of the krill fishery raises concerns about the future of the vulnerable and still little understood Antarctic marine ecosystem. This is particularly important, taking into account the history of over-exploitation of marine species in the Southern Ocean. This pattern has included seals in the 19th century, the great whales in the middle of the 20th century, the marbled rockcod *(Notothenia rosii)* in the early 1970s and, most recently, some populations of Patagonian toothfish *(Dissostichus eleginoides)*.

Although scientific understanding of the distribution and abundance of krill is progressing, information about the critical relationship between krill and other species in the Antarctic marine environment is still limited. The main concern related to this fishery is that the perceived massive abundance of Antarctic krill, the expected growing demand for krill products, and the restrictions to krill fishing imposed in the Northern Hemisphere, might result in increased fishing pressure with excessive local impacts on predators in certain areas of the Southern Ocean, before appropriate management procedures are developed.

With all this in mind, it is surprising that the Antarctic krill fishery still constitutes an exception in regards to most of the basic regulatory requirements applicable to other Southern Ocean fisheries. The goal of this paper is to draw CCAMLR Members' attention to current concerns related to the Antarctic krill fishery and its potential impact on krill predators. Particularly significant are the needs to improve current control and reporting requirements applicable to the krill fishery, and to set adequately precautionary quotas for small management units before excessive localised fishing effort occurs.

2. About Antarctic krill

Antarctic krill are among the world's most abundant metazoan species,[1] and have been recorded as forming the largest aggregation of marine life.[2] It has also been said that Antarctic krill has great untapped fisheries potential.[3]

The extended distribution of krill was behind the designation of the management area for CCAMLR.[4] The total surface of the distribution is approximately 36 million square kilometers (this represents four and a half times the area of Australia). Krill population dynamics seem to be affected by sea ice conditions on different levels. Generally, favorable sea ice conditions allow for early reproduction that leads to a successful spawning event in the summer.[5]

The low recruitment rates for *E. superba* observed in recent years are troubling.[6] Possible long-term changes like global warming or ozone depletion could have significant effects at the individual or population level of euphausiid species. In the case of Antarctic krill, an observed increase in air temperature over the Southern Ocean, affecting sea surface temperature and sea ice conditions, could affect krill recruitment and krill stock size in the long term. Ultraviolet-B radiation is another variable that might affect near-surface krill concentrations and increase mortality rates, leading to a reduction in recruitment success and overall krill biomass.[7]

3. The Antarctic krill fishery

Practically all of the Antarctic krill fishery occurs within the CCAMLR Area, although significant quantities of krill have been found in FAO Statistical Division 41.3.2, adjacent to the Convention Area just north of Subarea 48.1. There are three main geographical regions within the CCAMLR Area where krill has been historically harvested: off Kemp Land; off Wilkes Land; and on the South West Atlantic.

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[1] Nicol, S. 1994. Antarctic krill: changing perceptions of its role in the Antarctic ecosystem. In: *Antarctic Science* – global concerns. (G. Hempel, ed.) Springer-Verlag, Berlin, Heidelberg, and New York: 144-166.

[2] Macauley, M.C., English, T.S., and Mathisen, O.E. 1984. Acoustic characterisation of swarms of Antarctic krill (*Euphausia superba*) from Elephant Island and Bransfield Strait. *J. Crustacean Biol.* 4 (Vol.1): 16-44.

[3] Nicol, S. and Endo, Y. 1997. Krill fisheries of the world. *FAO Fish. Tech. Pap*. 367.

[4] The distribution of Antarctic krill extends from the High Antarctic Continental Shelf north as far as the Antarctic Polar Front Zone, with centers of abundance in the Scotia Arc and some regions close to the continent in the Indian Ocean sector.

[5] Individual regions of the Southern Ocean show significant inter-annual variability in ice coverage. For example, marked differences in ice coverage between the Antarctic Peninsula region and the Indian Ocean sector are frequently seen. Consequently, krill recruitment indices for different sub-regions of the Southern Ocean need to be estimated and interpreted separately. Siegel, V. 2000. Krill (Euphausiacea): life history and aspects of population dynamics. *Can. J. Fish. Aquat. Sci*. 57 (Suppl. 3): 130-150

[6] Id.

[7] Id.

Interest in krill fisheries began in the 1960s, when a total catch of more than 150 million tonnes was projected, representing the so-called "krill surplus" caused by the great reduction in baleen whale stocks.[8] Another important factor in the development of the krill fishery was the declaration of 200 mile Exclusive Economic Zones (EEZs) in the late 1970s, which caused distant water fishing nations to turn to international waters for new fishing grounds.[9]

The amount of krill harvested to date has been estimated to be around 5.74 million tonnes of which the former Soviet Union and two of its succeeding states (Russia and Ukraine) have taken almost 84%, and Japan 14.5%. More than 90% of the catch has come from the western Atlantic Ocean sector of the Southern Ocean.[10]

The highest krill catches occurred in the early 1980s, reaching over half a million tonnes. Problems in krill processing and rising interest in finfish caused a considerable decline in krill catches in the 1982/83 and 1983/84 seasons. From 1986 to 1991, annual catches stabilized at around 350,000 to 400,000 tonnes. In the following seasons, catches dropped again due to the break-up of the Soviet Union, which forced this fleet to cease operations.[11] The Antarctic krill fishery has been stable for the last decade with catches around 100,000 tonnes (see Appendix 2, table 1).

In the first years of the fishery, krill catches were largely used for animal feed, particularly by countries of the former Soviet Union. Today, most krill is processed for aquaculture feed, bait and human consumption. The use of krill in aquaculture and its potential utilisation in biochemical products is generating an increasing interest in krill fisheries.[12]

In most recent years, almost all krill fishing vessels have been operating in the south west Atlantic region, where the catch rate has historically been higher (50 -150 tonnes per vessel)[13] and where the most predictable concentrations of krill are found.[14]

4. Projected catches: the future of the krill fishery

At the CCAMLR XXII meeting (October 2003), the Commission was informed about the krill fishing plans of Member countries for 2003/04. In total, the projected krill catch for the season was more than 30% greater than the expected total catch for the 2002/03

[8] Ichii, T. 2000. Krill harvesting. In: *Krill: Biology, Ecology and Fisheries* – (I. Everson, eds.) Fish and Aquatic Resources, Series 6. Blackwell Science, Oxford: 228-262.
[9] Nicol, S. and Endo, Y. (1999) Review. Krill fisheries: Development, management and ecosystem implications. *Aquat. Living Resour*. 12 (2): 105-120.
[10] Kock, K.-H. 2000. Understanding CCAMLR's approach to management. Available at: www.ccamlr.org
[11] *Supra* note 9.
[12] *Supra* note 11.
[13] *Supra* note 9.
[14] Miller, D.G.M. and Agnew, D. 2000. Management of Krill Fisheries in the Southern Ocean. In: *Krill: Biology, Ecology and Fisheries* – (I. Everson, ed.) Fish and Aquatic Resources, Series 6. Blackwell Science, Oxford: 300-337.

season.[15] This projected increase was considered significant by the Commission because in most previous years, total future catch levels indicated to the Scientific Committee had been at or below existing catch levels.[16]

The Scientific Committee, the Working Group on Ecosystem Monitoring and Management (WG-EMM) and the Commission, have all acknowledged the need to obtain more accurate information from CCAMLR members on their future fishing plans. The absence of complete and reliable information on future plans is precluding these bodies from predicting trends in the krill fishery which would be key for the management of krill stocks.[17]

The WG-EMM meeting in 2003 concluded the following:

"The Working Group recalled that at its last meeting it indicated to the Scientific Committee the difficulty it had understanding the trends in the krill fishery and it noted that representatives from only two of the fishing nations had attended the 2003 meeting of WG-EMM. Consequently, information available to the Working Group on future fishery plans was incomplete, anecdotal, and was not sufficient to make any assessment of developments in the krill fishery"

(...) "The Scientific Committee was advised that if WG-EMM was expected to assess the status and trends in the krill fishery, then it needed annual submission of information on the detailed fishing plans of all Member nations which would include at a minimum: the number of vessels, the locations of planned fisheries and the expected catch levels".[18]

[15] For example, according to these reports, Russia was planning to introduce two vessels to harvest 25,000 tonnes of krill in the 2003/2004 season. This is very significant since Russia, a major player in the fishery historically, had been inactive in krill fishing since 1993/94, shortly after the break-up of the Soviet Union. The indication that Russia is now entering the krill fishery again poses some potentially substantial questions related to the future expansion of the fishery. Also significant were Ukraine's plans to double its krill catches during the current fishing season. Korea also informed about its plans to increase krill catches in nearly 30%. The United States, Poland and Japan were expecting to keep a similar level of krill catches. However, the United States informed that it might introduce a second vessel. CCAMLR WG-EMM. 2003. *Report of the Meeting of the Working Group on Ecosystem Monitoring and Management*, Cambridge UK, 18 to 29 August 2003, paragraph 3.6.

[16] CCAMLR. 2003. *Report of the Twenty-Second Meeting of the Commission*, Hobart, Australia, 27 October- 7 November 2003, paragraph 4.35.

[17] In an attempt to overcome this insufficient reporting, CCAMLR's Scientific Committee has developed a pro forma which Members can use to submit information on their krill fishing plans. The Commission has urged Members to complete these questionnaires and submit them to the Secretariat prior to the 2004 meeting of the WG-EMM. However, submission of this kind of information is only voluntary and some Members have expressed concerns that these questionnaires include information requests regarding post-harvest processing of krill, which may be regarded to be in breach of commercial confidentiality. These concerns might restrict significantly the amount of useful information submitted to the Secretariat on detailed fishing plans and projected products. *See* Id., paragraphs 4.36-4.39.

[18] *Supra* note 16, paragraphs 3.7-3.8

Some recent developments in the krill fishery and markets have been interpreted as indicators that an increase in the fishery may be about to occur.[19] The main driving factor is an expected increase in demand for krill products, particularly for aquaculture feeds but also for pharmaceutical uses. Furthermore, increasing restrictions to access to krill fisheries in the Northern Hemisphere –fuelled by opposition to expanding krill fishing from local fishing industries, fishery managers and conservation groups- is very likely to intensify pressure on Antarctic krill stocks. [20]

Aquaculture, especially salmon farming, is experiencing an important scarcity of feed supply. The fish farming industry already uses up around 75% of the world's fish oil and around 40% of the world's fish meal. By 2010, these figures might go up to 90% and 56% respectively, according to predictions by the International Fish Meal and Fish Oil Manufacturers Association (IFOMA). FAO has indicated that, by 2010, farmed salmon and trout alone could consume 620,000 tonnes of fish oil.[21] . With demand exceeding supply and rising prices, this fish product has been labelled "the new blue gold".[22]

This lack of supply, along with increasing concerns over contaminants in aquaculture feeds, is leading the industry to urgently seek feeding alternatives. An adequate substitute for wild fish has not been found.[23] Krill demand as aquaculture feed is likely to increase due to its excellent value as nutrient source for farmed fish and crustaceans (protein, energy, essential amino acids). Other outstanding properties of krill are its natural pigment content, its palatability, its low content of pollutants, and its likely improvement of larval fish survival. These attributes make krill a more attractive feed than potential competitors such as squid meal, clam meal, artemia soluble, and fish soluble. [24]

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[19] Nicol, S. and Foster, J. (2003) Recent trends in the fishery for Antarctic krill. *Aquat. Living Resour*. 16: 42-45.

[20] With respect to current constraints to foresee the future of CCAMLR's krill fishery, in 2002, the Commission highlighted the importance of identifying the market factors critical to the krill fishery and evaluating how these factors might be monitored to assess the potential development of the fishery. CCAMLR (2002), *Report of the Twenty-First Meeting of the Commission* (CCAMLR-XXI), Hobart, Australia, Hobart, Australia, 21 October- 1 November 2002, paragraph 4.27.

[21] Staniford, D. (2002) A big fish in a small pond: the global environmental and public health threat of sea cage fish farming. Paper presented at "*Sustainability of the Salmon Industry in Chile and the World*". Workshop organised by the Terram Foundation and Universidad de los Lagos in Puerto Montt, Chile, 5-6 June 2002.

[22] Staniford, D. (2001) Cage Rage: an inquiry is needed into Scottish Fish Farming. The Ecologist (22/10/2001).

[23] Vegetables feeds, such as soya or seaweeds, are being used in salmon and cod farming but a problem exists regarding the final taste of the farmed fish when these products are utilised.

[24] Sclabos, D. 2003. The Krill. Available at: www.aquafeed.com (October 2003). Another attribute that is likely to increase krill's potential is its high concentration of Omega 3 fatty acid, which increases the natural Omega 3 content of farmed fish fed with diets containing krill. Sclabos, D. and Toro, R. 2003b. Natural Foods through marine krill meal. Available at: www.aquafeed (September 2003). In the salmon farming industry, PCB contamination in the fish meal that has been traditionally used are leading the industry's attention to krill. For example, the Norwegian Institute for Marine Research has found that krill is a viable alternative to fish oil, with less PCBs because of its lower position in the food chain. A Chilean research organization, called "Fundación Chile", has also highlighted the advantages of Antarctic krill as

Taking all this into account, the prospects for a growing demand and rising prices for krill-based products are very high. In addition, an increasing interest in developing pharmaceutical products from krill has been observed. These might become high-value by-products that could contribute to the profitability of the fishery.[25] Stocks in the Southern Ocean seem to be the most obvious source for krill. In light of these developments, an expansion of the Antarctic krill fishery seems inevitable.

5. CCAMLR's Management of Antarctic Krill

5.1 Precautionary catch limits

Krill fishing has been central to CCAMLR since its inception. The rapid expansion of the krill fishery in the 1970's and concerns that a species which plays such a critical role in the Antarctic marine ecosystem might be rapidly over-exploited, contributed to the sense of urgency that shaped the establishment of the Convention.[26]

The key role of krill in the Antarctic ecosystem also had a shaping effect of the basic principles embraced by CCAMLR in its Article II. The Convention was the first international fisheries arrangement to incorporate the ecosystem and precautionary approaches as basic principles. The ecosystem approach has imperative implications for CCAMLR's management of the krill fishery. There is a need to consider not only krill but also a subset of dependent species, including seabirds and seals, which are monitored by the CCAMLR Ecosystem Monitoring Program (CEMP). To take into account the needs of krill dependent species, more conservative reference points than the ones commonly applied in a single-species fisheries management were adopted.[27] The CEMP assessment of the impact of krill fishing on dependent species is to be integrated into long-term management procedures so as to allow the continuous adjustment of relevant measures in response to new information. This long-term strategy has been described as "feedback management".[28]

In the interim, CCAMLR has recognised that precautionary decisions need to be adopted to take into account existing uncertainties. This "predictive approach" is opposed to reactive management where decisions are made only in reaction to overwhelming evidence for the need to take action.[29]

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aquaculture feed for the salmon industry. *Ecoceanos News*, Santiago de Chile, 16 January 2004, available at: www.ecoceanos.cl.

[25] *Supra* note 20.

[26] *Supra* note 15.

[27] Id.

[28] Constable, A.J., de la Mare, W.K., Agnew, D.J., Everson, I., and Miller, D. (2000). Managing fisheries to conserve the Antarctic marine ecosystem: practical implementation of the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR). *ICES Journal of Marine Science*, 57: 778-791.

[29] Constable, A.J. (2002), CCAMLR Ecosystem Monitoring and Management Future Work. *CCAMLR Science*, Vol. 9: 233-253.

Having adopted the ecosystem approach, CCAMLR recognised that when looking at large-scale interactions (at statistical division or subarea), it was necessary to develop models to estimate appropriate levels of krill harvesting or yield, that would account for predator needs. It was concluded that the Maximum Sustainable Yield model (MSY) was inappropriate to set adequate catch levels of krill since it assumes stability in natural systems, considers the exploited stock as coming from a single species, and relies on a predictable relationship between stock size/growth and fishing effort. Furthermore, MSY does not account for interactions between exploited stocks and other species, which is crucial to address the objectives of Article II of CCAMLR.[30]

In order to provide precautionary limits for krill catches, CCAMLR designed a "Krill Yield Model" (KYM). The KYM was developed after the second meeting of the CCAMLR Working Group on Krill (WG-Krill) in 1990, as a response to concerns raised about the level of krill exploitation in Subarea 48.3 (see Appendix 1).

CCAMLR first established catch limits for Antarctic krill in its X Meeting in 1991. Due to difficulties in defining krill stock boundaries,[31] a practical approach was adopted, which lead to the establishment of catch limits for areas where the fishery was known to be primarily located. These were Subareas 48.1, 48.2, 48.3 and to a lesser degree, 58.4. Interestingly enough, these Subareas, especially 48.1 and 48.3, include large colonies and breeding sites of land-based krill predators.[32]

Krill catch limits have been adopted in Areas 48 (Atlantic sector of the Southern Ocean) and 58.4 (Indian Ocean sector), covering just over 51% of the CCAMLR Area.[33] The current precautionary catch limit for krill in the Atlantic sector of the Southern Ocean currently is established by CCAMLR's Conservation Measure 51-01 (2002), [34] which

[30] In 1990, CCAMLR's Scientific Committee identified general operational management principles for setting catch limits for krill that were subsequently endorsed by the Commission: (i) aim at keeping krill biomass at a level higher than would be the case for single-species harvesting considerations and, in so doing, to ensure sufficient escapement of krill to meet the reasonable requirements of predators; (ii) focus on the lowest biomass that might occur over a future period, rather on the average biomass at the end of that period, as might be the case in a single-species context; and (iii) ensure that any reduction of food to predators which may result from krill harvesting does not disproportionately affect land-breeding predators with restricted foraging ranges as compared to predators in pelagic habitats. *Supra* note 29.

[31] The difficulty to delineate boundaries for krill stocks in the Southern Ocean has been related to the lack of sufficient knowledge of the extent in which krill are resident in various areas, or are transported between these areas by the eastward flowing Antarctic Circumpolar Current. Miller, D.G.M. and Hampton, I. (1989) Biology and ecology of the Antarctic krill (*Euphausia superba* Dana). *BIOMASS Sci. Ser*. 9, 166 pp.

[32] *Supra* note 15.

[33] These were first established at 1.5 million tonnes for area 48, and 390,000 tonnes for Subarea 58.4. *Supra* note 10.

[34] With regard to the Indian Ocean, precautionary catch limits for krill fishing in this area are established by Conservation Measures 51- 02 and 51- 03 (2002). According to Conservation Measure 51- 02, the total catch limit for krill in Statistical Division 58.4.1 shall be 440,000 tonnes, which is subdivided as follows: 277,000 tonnes west of 115ºE, and 277,000 tonnes east of 115ºE. Conservation Measure 51- 03 sets the precautionary catch limit in Statistical Division 58.4.2 at 450,000 tonnes. Both measures are to be kept under review by the Commission, taking into account the advice of the Scientific Committee.

subdivides the overall limit of 4 million tonnes into smaller limits for the following subareas:

- Subarea 48.1: 1,008 million tonnes
- Subarea 48.2: 1,104 million tones
- Subarea 48.3: 1,056 million tones
- Subarea 48.4: 0.832 million tones

These precautionary catch limits are complemented by the provision that, if the total catch in Area 48 in any fishing season exceeds 620,000 tonnes, the precautionary limits would be subdivided into smaller management units following the advice of the Scientific Committee. This so-called "trigger level" which directs the Commission to subdivide the overall limit into smaller areas, is expected to allow proper management of krill stocks in anticipation of a rapid expansion of the fishery.[35]

Krill catch data over the last years have shown that the major proportion of krill are taken in shelf or shelf break areas. These areas coincide with the foraging grounds used by land-based predators, like penguins, to obtain food to rear their offspring. Therefore, in spite of the subdivision of the overall catch limit for krill in the Atlantic sector of the Southern Ocean into subareas, concern remains about the localised impact that large fishing effort concentrated in small parts of a subarea may have on krill populations and land-breeding predators.

In 2002, the Commission subdivided the subareas in Area 48 into 15 smaller units for the management of the krill fishery (Small-Scale Management Units or SSMUs). The Commission also directed the Scientific Committee to consider how the krill catch limit could be allocated among these SSMUs.[36]

Three SSMUs (Antarctic Peninsula Drake Passage West, South Orkney West and South Georgia East) have accounted for 66% of the total krill catch in Area 48 over the past 10 years, and two others (Antarctic Peninsula Drake Passage East and Antarctic Peninsula Elephant Island) account for a further 20% of the total (see Appendix 2, table 2). Accordingly, these five SSMUs concentrate the vast majority of the krill catch. This is significant because these areas are all adjacent to predator colonies. On the contrary, available data show that pelagic SSMUs have concentrated considerably smaller levels of catches for the last decade. This concentration of krill catches on areas adjacent to predator colonies need to be taken into account when setting precautionary limits, in order to minimise potential impacts of the fishery on krill dependent species.

As acknowledged by the Commission, these newly-defined SSMUs are key for the development of management procedures for krill fisheries that can adequately account for

[35] *See* CCAMLR. Krill Synoptic Survey. Available at: http://www.ccamlr.org/pu/e/sc/kri-surv-intro.htm
[36] *Supra* note 21, paragraph 4.6.

localised effects on krill predators. The Scientific Committee, and particularly the WG-EMM, is now given the task of providing advice to the Commission on how to subdivide existing precautionary catch limits amongst SSMUs. At the 2003 meeting of the WG-EMM, four possible options were put forward taking into account different factors.[37]

Any scientific advice given to the Commission on this issue has to deal with a considerable degree of uncertainty on the interaction between fishing operations and krill predators. Currently, as mentioned before, fishing effort is concentrated in a small number of SSMUs adjacent to land-based predator colonies. The WG-EMM has concluded that there is a need to refine the subdivision options presented in 2003 and to develop additional options, taking into account historical information from the krill fishery. A call has been made for additional proposals to be developed during the inter-sessional period, with the view of forwarding a recommendation to CCAMLR XXIII in 2004.[38]

5.2 Other CCAMLR measures applicable to krill fishing

The Antarctic krill fishery is subject to some of the general requirements that are applicable to all CCAMLR fisheries. For example, Conservation Measure 10-01 (1998) establishes that Contracting Party vessels licensed to fish in the CCAMLR Area must be marked in such a way that they can be readily identified according to international standards. Conservation Measure 10-02 (2001) sets up general licensing and inspections requirements for vessels fishing in the Convention Area. According to this measure, only vessels holding a license that specifies fishing areas, species and time periods, are allowed to fish in the CCAMLR Area. Contracting Parties are required to provide details of the licences issued to the Secretariat. Conservation Measure 10-02 includes also minimum inspection requirements of vessels by the flag state at departure and arrival ports, in order to ensure compliance with CCAMLR conservation measures.

[37] The four options are: (i) the catch limit for an SSMU should be proportional to the combined estimated predator demand for krill in that SSMU. This option is based on the assumption that a high predator demand indicates a high standing stock for krill; (ii) the catch limit for an SSMU should be proportional to the estimated standing stock for krill in the SSMU (this option assumes that in all areas where krill occurs, high krill biomass densities imply high availability); (iii) the catch limit for an SSMU should be proportional to the estimated standing stock for krill in that SSMU, less the estimated predator demands (this option is based on the premise that the amount of krill allocated to the fishery should be determined only after accounting for predator needs); (iv) the catch limit for an SSMU should be calculated as an annually adjustable proportion of the catch limit resulting by one the three options above, after incorporating the value of an ecosystem monitoring index or a combination of indices. *Supra* note 16, paragraph 5.14.

[38] *Supra* note 17, paragraph 4.22.

Reporting requirements

Prior to 2002, the krill fishery was the only CCAMLR fishery which did not require mandatory submission of detailed catch and effort data. Until then, submission of CPUE and associated data was only voluntary.[39]

In 2002, the Commission responded to calls from the Scientific Committee that more detailed data for krill fisheries was needed and, therefore, data reporting requirements for the krill fishery were revised. Consequently, Conservation Measure 23-06 (2002) was adopted, establishing a data reporting system for krill fisheries. According to this system, krill catches are to be reported to the Commission on a monthly basis. In addition, Contracting Parties shall obtain from their vessels fine-scale catch and effort data for each season, to fulfil the requirements of a CCAMLR official "trawl fisheries form". Parties are further required to aggregate these data by 10 x 10 n mile rectangle and 10-day period, and transmit those data to CCAMLR's Executive Secretary by April 1st of the following year.

Despite these new reporting requirements, more detailed information on the krill fishery is still needed. The Commission, the Scientific Committee, and the WWG-EMM have repeatedly stated the need to obtain haul-by-haul data on krill fishing operations in order to be able to make adequate management decisions, or give informed advice. For example, according to the WG-EMM, haul-by-haul data for a number of years are needed for examining trends in krill distribution abundance. This working group has also noted that aggregated data currently submitted under the format of Conservation Measure 23-06 do not allow for analysis of the data following recommended standardised methods.[40] Currently, submission of fine-scale data on a haul-by-haul basis are required for most of CCAMLR fisheries but not for krill.

In addition, the Commission has acknowledged that additional information on aspects such as vessel type and product type would be key for the interpretation of CPUE data from the krill fishery.[41] Reporting should include an assessment of catch time as well as catch per tow.[42]

In relation to this point, it is interesting to note that the Scientific Committee has explicitly recommended requiring reporting of haul-by-haul data by 10-day periods once the precautionary catch limit for krill in Area 48 is subdivided among SSMUs. The Commission has echoed this requirement.[43]

[39] *Supra* note 21, paragraph 4.27.
[40] *See supra* note 16, paragraphs 3.15-3.26.
[41] *Supra* note 21, paragraph 4.27.
[42] *See supra* note 16, paragraphs 3.15-3.26
[43] *Supra* note 21, paragraph 4.9.

Monitoring, Control and Surveillance (MCS)

CCAMLR's MCS regime is very weak when it relates to the krill fishery. For example, CCAMLR does not currently require the presence of scientific observers on vessels fishing for krill in the Convention Area. Although CCAMLR has designed a "Scheme of International Scientific Observation", there is no conservation measure making it compulsory for krill fishing. CCAMLR conservation measures require the presence of scientific observers on board vessels participating in other fisheries, such as toothfish, icefish, crab, macrourus, etc, but the krill fishery constitutes an exception to this rule.[44]

The same can be said about the requirement that fishing vessels operate an automated satellite-linked Vessel Monitoring System (VMS). Conservation Measure 10-04 (2002), requiring Contracting Parties to monitor the position of all of its fishing vessels licensed to fish in the Convention Area via a VMS, is applicable to all CCAMLR fisheries except for krill.[45]

6. Ecological concerns: impact on dependent species

Good circumstantial or inferential evidence exists for potential competition for krill between fishing vessels and krill predators. This evidence is especially based on consumption rates in local areas and at particularly critical times of the year for predators.[46] In relation to this issue, the Scientific Committee has observed difficulties in determining whether ecosystems changes are caused by fishing operations or by environmental factors. A key issue for CCAMLR is the need to develop a management procedure for the krill fishery that adequately takes into account these uncertainties on the basis of precaution.

In the South Atlantic (Area 48), the risk of excessive krill catches being taken from small areas where impact on krill dependent predators might occur, needs to be considered in relation to the current trigger level of 620,000 tonnes. According to Conservation Measure 51-01, once this trigger level is reached, current catch limits shall be subdivided amongst SSMUs. The question arises whether this trigger level is appropriate to avoid a significant decrease of krill availability for predators in local areas, considering the event that the majority of the catch limit for a particular subarea were taken in a small part of that subarea.

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[44] The WG-EMM has suggested several changes to CCAMLR's "Scientific Observers Manual" in order to incorporate relevant data for the krill fishery, as well as the use of electronic logbooks as a key tool for the collection and submission of data. *Supra* note 16, paragraphs 3.38-3.45.

[45] With respect to VMS, the Commission noted at its 2003 meeting that Korea, Japan, Poland and Ukraine had submitted VMS reports in respect of their krill vessels on a voluntary basis. *Supra* note 17, paragraph 3.22.

[46] *See supra* note 16, paragraph 5.23.

A central factor in relation to the question above is how fast the krill fishery will expand in the near future. Although there is limited information on projected catches of the krill fishery, it is clear that a steady growing trend is occurring, which is a matter of concern for some CCAMLR leading scientists. For example, at the last meeting of CCAMLR's Scientific Committee in 2003, the view was expressed that if the projected rate of increase were to continue, the trigger level of 620,000 tonnes in Area 48 could be reached in five to six years, and that "the fishery may start to expand faster than the capacity of the Scientific Committee to provide management advice". It was generally acknowledged by the Scientific Committee that reliable information that would allow an assessment of how likely such an increase might be is currently not available.[47]

The impact of high krill catches taken in a small area, close to land-based predator colonies, would depend on krill availability in certain years. Thus, in years of poor krill availability, high concentrated catches in a small area might just make the difference between an average breeding year and a breeding failure. Also, concentrated fishing may have its maximum impact on predator breeding success, when fishing takes place on the immediate foraging area and at the critical breeding time. For example, in the Antarctic Peninsula, there is a summer fishery at the same time and in the same places as penguins and seals are foraging to rear their young.[48]

[47] SC-CCAMLR (2003), *Report of the Twenty-Second Meeting of the Scientific Committee* (CCAMLR XXII), Hobart, Australia 27-31 October 2003, paragraph 4.5.

[48] Another factor that has been related to potential future impact of the krill fishery is the seasonal constraints affecting the fishery linked to the expansion of iced areas around the Antarctic. In summer, krill fishing can spread out around many of the subantartic islands and the Antarctic continent and therefore, fishing pressure can be distributed to minimise local excessive impacts. On the contrary, in winter, the fishery is limited to small areas around South Georgia, where waters are generally ice-free. If the fishery requires a year-round operation to be viable, a conflict may arise between maintaining an economically sound fishery and ensuring that winter catches in South Georgia remain at sustainable levels. Nicol, S. and Endo, Y. (1999) Review. Krill Fisheries: Development, management and ecosystem implications. *Aquat. Living Resour*. 12 (2): 105-120.

7. Recommendations

1. Subdivision of precautionary catch limits amongst SSMUs in the South Atlantic

It is imperative for CCAMLR to subdivide the precautionary catch limits for Area 48, amongst the 15 SSMUs established in 2002, well before the 620,000 tonnes trigger level is reached. This allocation of catches should be decided on the basis of precaution, ensuring that the amount of krill allocated to the fishery does not affect krill availability for predators. In the absence of scientific certainty on the impact of krill fishing on krill dependent predators in certain SSMUs, further expansion of the fishery should be avoided in coastal areas, adjacent to predator colonies. In these cases, further effort should be directed to pelagic SSMUs only.

2. Reporting requirement on a haul-by-haul basis

CCAMLR should establish the requirement of submission of standardised, fine-scale data on a haul-by-haul basis for the krill fishery. This is presently required for most CCAMLR fisheries but not for krill. The Commission and the Scientific Committee have repeatedly stated the need to obtain haul-by-haul data on krill fishing operations in order to be able to make adequate management decisions.

3. Requirement of VMS for all vessels fishing for krill

The krill fishery should be subject to the same controls as the other fisheries operating in the CCAMLR Area. This should include the requirement that all the vessels that fish for krill in the Convention Area, should maintain an automated Vessel Monitoring System that allows the flag state to monitor the position of the fishing vessels constantly. This is important to make sure that fishing areas are respected. Consequently, Conservation Measure 10-04 (2002) should be amended to remove the exception of VMS requirement for vessels fishing for krill.

4. Requirement of scientific observers

The presence of scientific observers on board fishing vessels is necessary for the gathering of relevant data on different aspects of the fishery that are key for the Scientific Committee to provide adequate management advice to the Commission. There is no reason why the krill fishery should be an exception to the general requirement for scientific observers on board of vessels fishing in the CCAMLR Area. Therefore, CCAMLR should require that each vessel fishing for krill in the Convention Area shall have at least one scientific observer on board, appointed in accordance with the CCAMLR Scheme of International Scientific Observation.

5. Submission of detailed fishing plans

For the Scientific Committee to adequately assess the krill fishery and provide adequate management advice, CCAMLR should require Members to submit annual reports of their detailed fishing plans, including number of vessels, locations of planned fisheries and expected catch levels.

6. Enhance coordination of scientific programmes related to krill

The fieldwork and data acquisition that constitute the basis for the development of scientific advice to CCAMLR management of the krill fishery are carried out voluntarily by CCAMLR Members. In view of the complexity of the scientific programmes undertaken, and the important uncertainties faced in relation to the krill fishery, it is essential that CCAMLR Members take decisions that allow them to maximise these expensive research programmes to contribute to CCAMLR conservation management goals. In this context, further development of coordinated programmes are needed in order to provide broader spatial and temporal coverage in areas close and at a distance from krill fishing operations.[49]

[49] *See supra* note 30.