

**THE NEED FOR A STRATEGIC PLAN FOR THE MANAGEMENT OF
THE ANTARCTIC KRILL FISHERY**

**THE ANTARCTIC AND SOUTHERN OCEAN COALITION
(ASOC)
Paper for XXVI Meeting of CCAMLR, October-November 2007**

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Executive Summary

The Antarctic krill fishery is the largest fishery in the Southern Ocean. It targets Antarctic krill (*Euphausia superba*), a keystone species for the Antarctic marine ecosystem and the main prey for most top predators in Antarctica. Therefore, krill fishing has significant ecosystem implications that need to be taken into account by CCAMLR, especially as a result of the ecosystem and precautionary approaches embraced by Article II of the Convention.

Although catch limits exist for krill in the South Atlantic, where the fishery currently operates, these limits are set for large areas of the ocean, and do not take into account the interaction between the fishery, krill and krill predators, which occur at much smaller scales. Virtually all the krill catch is concentrated within 100 km of known breeding colonies of land-based krill predators in the South Atlantic. It is very difficult to quantify the feeding needs of krill-dependent predators in those areas where overlapping between the fishery and krill predators occurs. The combined impact of climate change and krill fishing pose an additional challenge for an ecosystem-based management of the krill fishery.

For the reasons outlined above, CCAMLR has acknowledged the need to adopt feedback management procedures for the krill fishery, by which management measures are continuously adjusted to relevant information -as it becomes available- on the interactions between krill, fisheries, krill predators, and the environment. It is also acknowledged that management at a small scale is needed to account for predator-prey relationships. The current management system based on annual krill catch limits for the krill fishery in the South Atlantic is therefore considered by CCAMLR as an interim solution until mechanisms are in place that allow for these feedback management procedures to be developed and implemented. Furthermore, these annual catch limits are complemented by the establishment of a trigger level of 620,000 tonnes in the South Atlantic aimed at ensuring that fishing effort does not greatly exceed historical catches until an adequate, small-scale management regime is in place.

Establishing such a small-scale, feedback management regime for the South Atlantic is a complex task. Many scientific uncertainties remain, and monitoring of land-breeding predators is still insufficient to establish a full feedback management regime across the whole area where the fishery operates. In the meantime, interest in krill fishing is rapidly growing, as evidenced by notifications of intent to fish for krill in the upcoming 2007/08 season, which for the first time exceed the trigger level. Krill fishing is already attracting non-CCAMLR Members, and there is the potential for the fishery to move to new areas where no management arrangements exist. The use of new technologies to fish and process krill are changing the economics of the fishery and poses new management challenges.

CCAMLR needs to face these challenges as a matter of urgency to ensure that the krill fishery develops in response to management rather than the reverse. This paper argues the need for CCAMLR to develop a strategic plan for krill fisheries as the most effective way to address the different scientific, policy and regulatory elements that are relevant to krill fisheries management.

These elements should be integrated into a strategy that responds to a long-term ecosystem vision for Antarctica. In view of CCAMLR principles and the vital role of krill in the Antarctic marine ecosystem, the development of such a strategic plan, with appropriate advice from the Scientific Committee, should be a high priority for the Commission.

In the short-term, and as part of such a strategic plan, CCAMLR should ensure that no expansion of the krill fishery occurs beyond the trigger level in the South Atlantic until adequate management procedures are in place. In addition, precautionary measures should be adopted to ensure that the potential fishery expansion to other areas of the Antarctic does not pose a threat to krill predator populations, in accordance with the precautionary approach.

This paper also puts forward a few regulatory reforms that are urgently needed as first steps of CCAMLR's strategic plan for krill fisheries management. Among them, ensuring that no expansion occurs beyond the trigger level in the upcoming season, securing systematic scientific observer coverage on board the krill fishery, and requiring cVMS on all krill vessels, should be the highest priorities.

CCAMLR Members are the stewards of krill and krill predators, and of the wider Antarctic marine ecosystem. CCAMLR has taken very important first steps that set the foundation for effective, ecosystem-based management. It now retains a unique window of opportunity to ensure that the krill fishery develops in a way that responds to CCAMLR's mandate and spirit, for the sake of Antarctica's natural balance.

1. CCAMLR, ANTARCTIC KRILL, AND THE ECOSYSTEM APPROACH

CCAMLR is the first international agreement to incorporate ecosystem and precautionary approaches as basic principles for the management of marine living resources. Specifically, the ecosystem approach stated in Article II, (3)(b) of the Convention delineates the need to maintain the ecological relationships between harvested, dependent and related populations of Antarctic marine living resources, and to restore depleted populations.

Article II, (3) (c) embodies a clear requirement for the application of precautionary approaches to management. This provision requires that harvesting is conducted in a way that minimizes the *“risk of changes in the marine ecosystem which are not potentially reversible over two or three decades, taking into account the state of available knowledge of the direct and indirect impact of harvesting, the effect of the introduction of alien species, the effects of associated activities on the marine ecosystem and the effects of environmental changes, with the aim of making possible the sustained conservation of Antarctic marine living resources.”*

CCAMLR is recognised as the only regional fisheries body that routinely carries out a comprehensive application of the ecosystem approach to fisheries management. Specific achievements include, *inter alia*: the development of a precautionary approach to the management of target species; the collection of data on by-catch and ecosystem impacts through the CCAMLR Scheme of International Observation; the adoption of effective seabird by-catch mitigation rules and other gear restrictions to minimize the ecosystem impacts of fishing; and the development of specific policies to manage new and exploratory fisheries (Willcock & Lack, 2006).

Antarctic krill (*Euphausia superba*) is the main prey species for many top predators in the Antarctic. Therefore, krill fishing has significant ecosystem implications that need to be taken into account by CCAMLR's management. In fact, the key role of krill in the Antarctic ecosystem and concerns about this fishery influenced the negotiation of the Convention and the formulation of the conservation principles embraced by CCAMLR in Article II.

This paper argues the need for CCAMLR to develop a strategic plan for krill fisheries as the most effective way to address the different scientific, policy and regulatory elements that are relevant to krill fisheries management. These elements should be integrated into a strategy that responds to a long-term ecosystem vision for a krill fishery that allows for the maintenance of Antarctica's natural balance. In view of CCAMLR principles and the vital role of krill in the Antarctic marine ecosystem, this should be a high priority for CCAMLR.

2. BRIEF HISTORY OF CCAMLR REGULATION OF KRILL FISHING

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 that plays such a critical role in the Antarctic marine ecosystem might be rapidly over-exploited, contributed to raising the sense of urgency that shaped the establishment of the Convention (Miller & Agnew, 2000).

The ecosystem approach has imperative implications for CCAMLR's management of the krill fishery. There is a need to consider not only krill (the target species) but also a subset of

dependent species, which include a wide range of krill predators such as fish, seabirds and marine mammals.

Since 1991, krill catch limits have been adopted in Area 48 and also in two divisions of the Southern Indian Ocean, covering in total just over 51 percent of the CCAMLR Area.

2.1 First introduction of krill catch limits and the trigger level

Since the first management arrangements for krill were developed in the early 1990's, CCAMLR acknowledged that the establishment of annual catch limits based on krill biomass estimates would not be sufficient to account for the risk of localised fishing impact on predator populations, and that an improved management would be needed, including the development of a "feedback management procedure". Under this feedback approach, management measures are continuously adjusted in response to relevant information.¹ Such a management scheme for krill, which still remains to be fully developed, needs to account for interactions between the fishery and krill predator populations.

In the absence of such a feedback management procedure, CCAMLR adopted an interim, *ad hoc* approach in order to set krill catch limits for the South West Atlantic (Area 48), where the fishery was primarily concentrated.

In 1991, the first precautionary catch limit for the krill fishery in Area 48 was established at 1.5 million tonnes which applied to Area 48 as a whole.²

Although in the early years the krill fishery operated all around Antarctica, most of the overall krill catch has been taken from the South West Atlantic, where the fishery has exclusively operated for the last decade. Most importantly, the majority of krill is harvested in shelf or shelf break areas, coinciding with the foraging grounds used by land-based predators dependent on krill, like seals and penguins, to obtain food to rear their offspring. Therefore, in spite of the adoption of catch limits for krill fishing for large areas of the ocean, concern remained about the impact on local krill populations and consequently, on land-breeding predators.³

The concern over the potential impact of concentrated fishing on land-based krill predators prompted CCAMLR to introduce a complementary provision to the establishment of a krill catch

¹ SC-CCAMLR, 1991, para. 3.66 and 3.103.

² In order to provide catch limits for the krill fishery, CCAMLR designed a "Krill Yield Model" (KYM). The KYM was developed in 1990 as an attempt to determine the proportion of krill biomass to be harvested each year that accounted for krill being prey for many species in the Antarctic. In the application of the KYM, the potential effect of krill harvesting on dependent predators was discussed and a "discount" factor was introduced in order to reduce yield calculations in a proportionate manner. The requirements of krill predators were incorporated by establishing a level of krill escapement of 75% of the estimated pre-exploitation biomass, instead of the 40-50% level normally used in single-species management. This has been called the "predator criterion" and it reflects an arbitrary level that needs to be revised to take into account information on the functional relationship between abundance of prey and recruitment in predator populations as it becomes available (Constable *et al.*, 2000).

³ Additional concerns have been expressed on the assumptions implied in the procedure used to determine precautionary catch limits in the South Atlantic, such as a freely distributed krill population, evenly distributed predation pressure, and randomly determined recruitment. It has been suggested that evidence generated from fine-scale catch data, monitoring indices, local krill surveys, and complementary studies show that these assumptions are not valid (Hewitt *et al.*, 2004a).

limit for Area 48 (48.1-48.3). Thus, in 1991, the Scientific Committee addressed the potential impact of localised fishing by recommending a combined approach conformed by two complementary elements:

- a) applying the precautionary krill catch limit for Statistical Area 48 derived from the KYM (1.5 million tonnes at that time), and
- b) limiting krill catches from existing fishing grounds near land-based predator colonies to the highest catches ever taken on these grounds. This was aimed at keeping the potential fishing impact on local predators contained close to historic levels.⁴

Accordingly, and in relation to element b) above, a provision was introduced in Conservation Measure (CM) 32/X (1991)⁵ that required krill catch limits to be established for smaller geographical areas if the total krill catch in any fishing season exceeds 620,000 tonnes. This limit, which was later called “trigger level”, was calculated summing the maximum historical krill catch in each subarea, and was intended to operate as an “*upper limit to catches on the existing fishing grounds*” near vulnerable land-breeding predator colonies.⁶

2.2 Current krill catch limits

In 2000, on the basis of new biomass estimates for the South West Atlantic resulting from the CCAMLR 2000 Krill Synoptic Survey, CCAMLR increased krill catch limits for Area 48 to the current 4 million tonnes limit. Krill catch limits are reflected in CM 51-01 (2002), which subdivides the overall limit of 4 million tonnes into lower limits for the following subareas:

- Subarea 48.1: 1.008 million tonnes
- Subarea 48.2: 1.104 million tonnes
- Subarea 48.3: 1.056 million tonnes
- Subarea 48.4: 0.832 million tonnes

In the context of the revision of krill catch limits for Area 48, the issue of the trigger level was reconsidered. The Commission recognised then the need to further develop a management procedure for krill consistent with Article II. It further acknowledged that this management procedure should include krill catch limits applied to smaller management units to take full account of spatial, particularly small-scale, requirements of land-based predators. As the Scientific Committee highlighted at that meeting, even the catch levels established by the new limits for each subarea could cause localised depletion if all the catch were taken from a confined area, especially in relation to the foraging needs of land-based predators.⁷

⁴ SC-CCAMLR, 1991, para. 3.83.

⁵ Now called 51-01.

⁶ SC-CCAMLR, 1991, para. 3.106 and 3.108.

⁷ SC-CCAMLR, 1991, para. 7.22.

Aware of the fact that an appropriate management procedure could take another five to ten years to develop, the Commission agreed, as a precautionary measure, to maintain the trigger level that had been introduced in 1991.⁸ Specifically, the 2000 Commission report reads as follows:

“As a precautionary step, the Commission agreed that krill catches should not exceed a set (i.e. ‘trigger’) level in Area 48 until a procedure for division of the overall catch limit into smaller management units has been established. This is consistent with the current Conservation Measure 32/X which sets such a trigger level at 620,000 tonnes – slightly above the historical maximum annual catch in Area 48 to date”.⁹

For the Indian Ocean sector, precautionary catch limits for krill fishing are established by Conservation Measures 51- 02 and 51- 03 (2002). According to CM 51- 02, the total catch limit for krill in Statistical Division 58.4.1 is 440,000 tonnes, which is subdivided as follows: 277,000 tonnes west of 115°E, and 163,000 tonnes east of 115°E. CM 51- 03 sets the precautionary catch limit in Statistical Division 58.4.2 at 450,000 tonnes.

2.3 Small-scale management units

In 2002, endorsing advice from the Scientific Committee, the Commission subdivided the South West Atlantic into fifteen small units for the management of the krill fishery known as Small-Scale Management Units (“SSMUs”). The Commission also directed the Scientific Committee to consider how krill catch limits could be established for these SSMUs.¹⁰

Since then, the Scientific Committee and its Working Group on Ecosystem Monitoring and Management (WG-EMM) have been considering approaches to allocate krill catch limits to the SSMUs defined in 2002. Six candidate procedures for this allocation have been put forward so far:

1. Spatial distribution of catches by the krill fishery;
2. Spatial distribution of predator demand;
3. Spatial distribution of krill biomass;
4. Spatial distribution of krill biomass minus predator demand;
5. Spatially explicit indices of krill availability that might be monitored or estimated on a regular basis;
6. Pulse-fishing strategies in which catches are rotated within and between SSMUs

In order to assess how well these different management procedures would meet CCAMLR’s objectives, simulation models and performance measures for krill, predators and the fishery are being developed.

⁸ CCAMLR, 2000, para. 10.10 and 10.11.

⁹ CCAMLR, 2000, para. 7.23.

¹⁰ CCAMLR, 2000, para. para. 4.27.

Last year, the Commission noted that this modelling work suggested that subdivision of the krill precautionary catch limit based on historical catch distributions from the fishery (Fishing Option 1-*status quo*) would have greater negative impacts on the ecosystem than other fishing options. The Commission also noted that although substantial progress had been achieved, the Scientific Committee still required further work to develop its advice concerning the six candidate procedures for subdividing the krill precautionary catch limit among SSMUs in Area 48.¹¹

In 2006, the Scientific Committee established a new Working Group on Statistics, Assessments and Modelling (WG-SAM). The main task of this working group is to serve as a technical body to address quantitative and modelling issues relevant to the other working groups. The Scientific Committee also decided that one of the priorities for WG-SAM for 2007 would be the development of a methodology for subdividing krill catch limits among SSMUs in Area 48.¹²

2.4 CCAMLR's Ecosystem Monitoring Program

Another important element in the management of the Antarctic krill fishery is CCAMLR's Ecosystem Monitoring Program (CEMP).

Established in 1985, the main goal of the CEMP is to monitor the effects of fishing on both harvested species (target species) and dependent species (predators), so as to assist CCAMLR in its task of regulating the commercial harvesting of Antarctic marine living resources in accordance with the "ecosystem approach" embodied in Article II (www.ccamlr.org). Based on a feedback management approach, it was expected that such a monitoring program would enable CCAMLR to adjust management measures in response to new information as it became available.

The idea behind the establishment of the CEMP was that krill predators could be good indicators of the availability of krill. The concept of indicator species was thus developed, referring to those dependent or related species that are likely to reflect changes in the species targeted by the fishery, and indicate the state of those parts of the ecosystem that are most impacted by fishing activities.¹³

A list of monitored parameters was developed for the CEMP, which includes predator, environmental and prey (krill) parameters. Fieldwork and data acquisition for predator parameters (indicator species) are voluntarily carried out by CCAMLR Member countries and submitted to the CCAMLR Secretariat. The Secretariat uses fisheries data submitted by Members to calculate some of the krill-related parameters. Furthermore, some environmental parameters, such as sea ice cover or sea surface temperatures are derived from publicly available datasets (Agnew, 1997).

¹¹ CCAMLR, 2006, para 4.8 and 4.9.

¹² SC-CCAMLR, 2006, para. 13.12.

¹³ The practice of monitoring the ecosystem as part of the management system is similar in its approach to that of an Environmental Impact Assessment (EIA) where monitoring is conducted after the implementation of a projected activity in order to assess its real effects (Agnew, 1997).

In order to facilitate data analysis and comparison between predator monitoring studies in the context of CEMP, the Scientific Committee developed a set of agreed Standard Methods for monitoring predator parameters.¹⁴

One of the challenges of the CEMP is to be able to distinguish whether a detected change in an indicator species is due to fishing or to environmental effects. Representativeness of the monitoring sites of their respective areas and regions constitutes another challenge.¹⁵

The CEMP is largely dependent on national research programs and priorities. Although management considerations influenced the initial selection of monitoring sites, this selection was also determined by practical considerations such as the presence of pre-established research stations. The continuity of contributions to the CEMP also depends on national priorities, since participation in the program is voluntary. As a result, the program is restricted to monitoring a few selected krill predators and is established in only a few areas. Currently, monitoring data is not available in several SSMUs that are regularly fished (Hewitt *et al.*, 2004 b).

The CEMP assessment of the impact of krill fishing on dependent species is to be integrated into long-term management procedures so as to enable the continuous adjustment of relevant measures in response to new information obtained, according to the feedback management approach adopted by CCAMLR. This issue has not been resolved yet and it should be a key element of CCAMLR's strategic plan for krill management. This idea is further elaborated in section 5.3 below.

3. CLIMATE CHANGE EFFECTS ON KRILL

Environmental factors impact Antarctic krill populations – with subsequent risks and impacts for the entire Antarctic ecosystem. The life history and demography of Antarctic krill are intimately tied to seasonal sea ice conditions, climate, and the physical forcing of ocean currents.

Key spawning, recruitment and nursery areas of krill are located in the Western Antarctic Peninsula (Constable *et al.*, 2003). The climate in this area is warming rapidly, and as a result, the extent and duration of winter sea ice are being reduced (Parkinson, 2002). Because of the strong linkages to climate and close coupling between trophic levels, environmental or biological perturbations can significantly affect all levels of the Antarctic marine ecosystem (Hofmann *et al.*, 2002).

As the reproduction and survival of krill are significantly affected by sea ice cover (Loeb *et al.*, 1997), decreases in krill biomass have been observed (Siegel & Loeb, 1995) and availability to predators is at times substantially reduced (Croxall *et al.*, 1988; Priddle *et al.*, 1998; Boyd *et al.*, 1994; Croxall *et al.*, 1999).

For example, a study recently conducted in the South West Atlantic - which contains more than 50% of the Southern Ocean krill stocks - has found a significant decline in krill density in this area since the 1970s. The results of this study show that summer krill densities correlate to both the

¹⁴ See CCAMLR Ecosystem Monitoring Programme: Standard Methods (2004).

¹⁵ SC-CCAMLR, 2003, para. 3.11 and 3.12.

duration and the extent of sea ice during the previous winter. It was also found that sufficient winter ice in the Antarctic Peninsula and Southern Scotia Arc, major krill spawning and nursery areas, affects krill density across the whole ocean basin, including areas north of the Seasonal Ice Zone (Atkinson *et al.*, 2004).

Based on the correlation of krill recruitment and seasonal sea ice dynamics, a changing physical environment of the Southern Ocean, and a warming trend in the Antarctic Peninsula, it has been noted that krill population levels and therefore availability to predators in the region may be in jeopardy (Quetin & Ross, 2003). Constable *et al.* (2003) also show that diminished sea ice cover over the past 20 years might result in greater recruitment variability and lower overall abundance of krill in the Southwest Atlantic, whereas recruitment may have been more stable and less variable in prior times. While it appears that the adult krill population is autocorrelated with environmental variables, recruitment is largely independent of the adult population size and is extremely variable (Hill *et al.*, 2006).

Optimal conditions for reproductive output around the Antarctic Peninsula occur when both the timing of the spring sea ice retreat and its maximum extent are both close to the long-term mean (Quetin & Ross, 2001). As the life cycle of krill are synchronized with mean annual conditions in the timing, duration, and extent of sea ice cover, deviation in either direction will affect either reproductive output and/or larval survival (Quetin & Ross, 2003).

Changes in predator populations concurrent to observed decreases in krill biomass have been documented. For example, Reid & Croxall (2001) have shown extreme variation in reproductive output for krill-dependent top predators breeding at South Georgia (fur seals, black-browed albatrosses, macaroni and gentoo penguins) in relation to annual krill availability. However, it is currently not clear whether such changes are directly due to harvesting of krill, or other causes such as environmental changes (Croxall & Nicol, 2004).

Fraser *et al.* (1992) showed that the decrease in winter sea ice in the Western Antarctic Peninsula due to climate warming has significantly contributed to long-term changes in the relative abundance of krill-dependent penguin populations. While the mechanisms by which environmental variability affect sea ice cover and krill demography are being investigated, how these changes cascade to other ecosystem components such as apex predators remain poorly understood at all spatial and temporal scales (Fraser & Hofmann, 2003).

CCAMLR's Scientific Committee has recently noted that the analysis of long-term population data from both the South Shetland and South Orkney Islands (Subareas 48.1 and 48.2) showed consistent declines in both Adélie and chinstrap penguin numbers over the past 20 to 30 years. As indicated, both species population declines may reflect the influence in reduction in prey (krill) availability linked to large-scale climate forcing.¹⁶

Generally, environmental change and variability are the most plausible explanations for why krill-dependent populations are changing. Some predators rely on sea ice and other environmental variables for successful breeding and foraging. In any case, there is widespread agreement in the scientific literature that the main cause for these population declines and decreased reproductive

¹⁶ SC-CCAMLR, 2006, para. 3.5 and 3.6.

outputs is limited prey availability. In order to understand and interpret natural ecosystem variability and how large-scale physical processes influence small-scale ecology in the Antarctic, long-term data series of krill predators are necessary (Reid & Croxall, 2001).

The potential cumulative impacts of climate change and fishing on krill and krill predators are unknown and need to be considered by CCAMLR's management of krill fisheries. In 2006, the Scientific Committee requested CCAMLR Members to consider "what the potential effects of climate change on Antarctic marine ecosystems might be, and how this knowledge could be used to advise the Commission on management of the krill fishery". The Scientific Committee has acknowledged difficulties in differentiating the effects of fishing from those of climate change. It has been suggested that an experimental fishing program could be used to help quantify these effects and that simulation studies using ecosystem models could help understand what these potential effects might be.¹⁷

In addition, the relationship between krill abundance and recruitment due to the extent of sea ice seems not to be consistent throughout different areas. Different ecosystem responses to environmental changes throughout the Antarctic need also be taken into account when taking monitoring and management decisions.

To conclude, while more information is necessary to understand how long-term changes in the physical environment will affect krill population dynamics, we do know that the breeding performance and success of krill-dependent predators depends on the frequency and magnitude of these events. This knowledge underscores how necessary it is to account for known or forecasted changes in krill availability to predators when setting krill catch limits for krill in areas where predators forage. An extensive and well-designed monitoring program will be key to the detection of local or regional adverse effects on krill or krill predators from a long-term krill decline that may be augmented by a fishery (Hewitt & Low, 2000).

4. A FISHERY IN EXPANSION

A potential krill catch of 764,000 tonnes was notified for the 2007/08 fishing season. This involves 25 vessels from nine notifying States, including non-CCAMLR Commission Members (Cook Islands and Vanuatu). If all the notified catch were taken in Area 48, where all the krill catch has been concentrated for the last decade, it would surpass by 136,000 tonnes the trigger level of 620,000 tonnes established in CM 51-01. There has been an increasing trend in notifications for krill fishing over the last years, as shown in Figure 1 below. Notifications were around 120,000 tonnes at the turn of the century, while fishing intent for the upcoming season has increased to 764,000 tonnes. This is an unprecedented increase in potential catch.

¹⁷ SC-CCAMLR, 2006, para. 3.7.

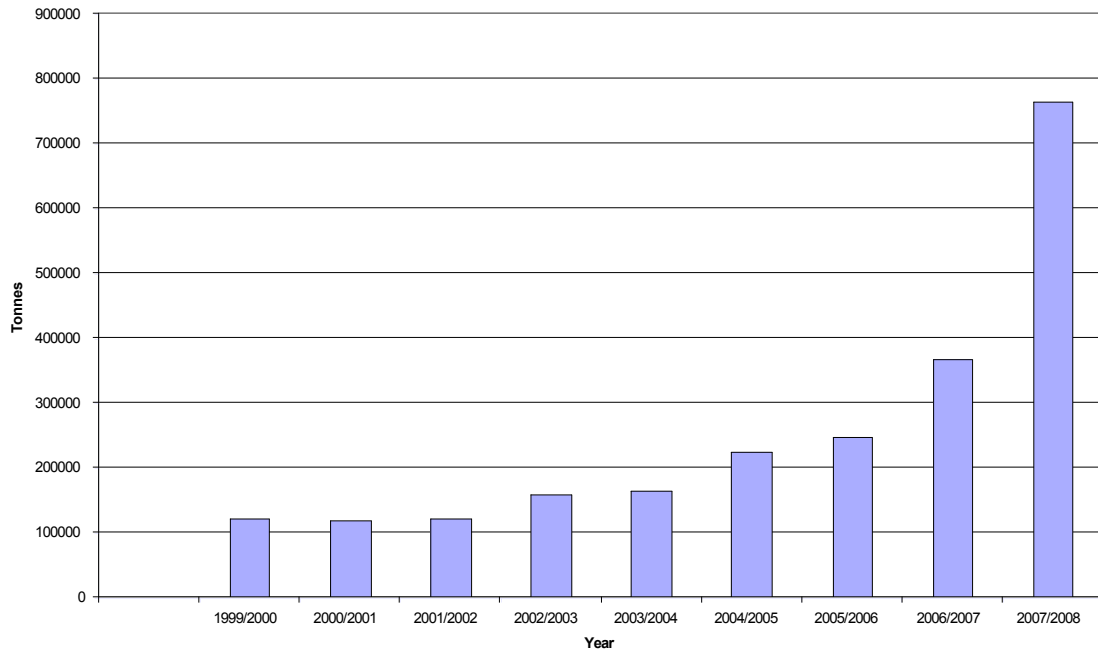


Figure 1. Evolution of notifications of intent to participate in the krill fishery 1999-2007.

Three factors have been driving this growth in interest in fishing for krill over the last years: increased interest in producing high value oils from krill,¹⁸ an increase in global fishmeal prices, and the development of improved technologies to fish and process krill.¹⁹

Krill fishing occurs in complete overlap with the foraging ranges of krill predators in the South West Atlantic -and potentially in other areas. Virtually all the krill catch is concentrated within 100 km of known breeding colonies of krill predators (Hewitt *et al.*, 2004 a). Should projected catches follow the historical pattern of krill fishing, the majority if not the totality of these catches would be concentrated close to land-breeding predator colonies, overlapping with their foraging ranges. Unless measures are taken to protect predators from competition with krill fishing vessels in the short and long-term, the expansion of the krill fishery may pose a significant threat to land-based predators, especially penguins in the South West Atlantic, in contravention of the conservation principles of CCAMLR's Article II.

¹⁸ Interest in krill oil is developing. For example, Canadian-based *Neptune Technologies and Bioresources Inc.* has announced a partnership with *Yoplait*, the second largest brand in fresh dairy products. *Neptune* and *Yoplait* have agreed to develop new products in the fresh dairy market including dairy products containing *Neptune's* krill oil. The aim is develop products which may have health-related benefits based on the *omega-3* containing krill oils. *Neptune* has also signed up a joint research project with international food giant *Nestlé*. The project is to look at "new frontiers for Neptune Krill Oil" and will link *Neptune* with the *Nestlé Research Center*. See <http://www.neptunebiotech.com/>

¹⁹ Especially the development by Norwegian fishing company *Aker Seafoods* of a technique to allow for continuous fishing and processing for krill.

5. A STRATEGIC PLAN FOR KRILL FISHERIES MANAGEMENT

CCAMLR has taken important steps towards implementing an ecosystem approach to the management of marine living resources. The full application of the ecosystem approach to the management of krill fisheries is likely to become CCAMLR's greatest test, due to krill's role in the Antarctic ecosystem.

The ecosystem approach to fisheries management requires maintaining the functional relationships between the different components of the ecosystem. This implies increasing the understanding on how these complex relationships work. Cumulative impacts must also be taken into account, including the action of exogenous impacts generated outside the region, such as climate change (Reid, 2007). The ability to detect these impacts through the monitoring of ecosystem responses needs to be developed.

In the context of an ecosystem approach to fisheries management, increased complexity means that management needs to deal with greater uncertainty. If uncertainties are dealt with adequately, this would make management much more effective and successful. An inability to deal with these uncertainties would make the management system extremely vulnerable. In the particular case of krill, a fishery expansion coupled with an inability to incorporate uncertainties could result in irreversible impacts to the Antarctic marine ecosystem.

Implementation of the ecosystem approach requires the consideration of complex elements into a long-term strategic plan that allows the development of science and monitoring needed for management, the formulation of management objectives and operational principles, and the adoption of precautionary measures to enable orderly fishery development that respond to this strategic plan. The existence of such a strategic plan allows strengthening the management regime, forcing the fishery to develop in reaction to the established management rather than the reverse (Hewitt & Low, 2000).

In the case of krill, the need for CCAMLR to develop a strategic plan has been already suggested and elaborated upon by Hewitt & Low (2000).²⁰ The proposed strategy included the following three elements: a) identification and monitoring of key processes governing krill abundance and dispersion; b) elaboration of resource management rules based on indicators of key processes; and c) research activities designed to reduce uncertainty, improve the monitoring performance of the management scheme, and describe key processes. Such a strategic plan would provide structure to a diverse range of activities that are currently being conducted by CCAMLR Members and working groups in support of CCAMLR conservation objectives. It would also allow CCAMLR to identify priorities in regards to critical issues that need immediate attention, while keeping a long-term vision that focuses on the ecosystem rather than on individual elements. This is an essential approach especially taking into account krill's vital role in the ecosystem.

CCAMLR is facing a critical moment in relation to ecosystem-based management of the krill fishery. Notifications of intent to fish for krill in the CCAMLR Area clearly indicate that the fishery

²⁰ In 2002, a group of CCAMLR scientists acknowledged that the full development of a feedback approach to management of krill fishing would require: 1) enhancement of CCAMLR's existing ecosystem monitoring program; 2) further development of models linking krill, their predators, environmental influences and the fishery; and 3) high-resolution, real-time information regarding the behaviour of fishing vessels (Hewitt *et al.*, 2002).

could expand considerably. Increasing effects of climate change on the Antarctic may be posing an extra threat to the balance of the krill-centric ecosystem. Fortunately, the work of WG-EMM and WG-SAM towards providing advice on the allocation of krill catch limits among SSMUs in the South West Atlantic is well advanced and much progress was made at this year's meetings. It would be key for CCAMLR to ensure that this advice is not delivered in isolation, but rather in the context of a strategic plan for the management of the krill fishery that takes into account all the different elements and possible scenarios, and integrates them into a long-term vision for the krill fishery around Antarctica. Such a strategic plan would provide a framework that would guide CCAMLR policies for krill fishing in different areas of the Antarctic, and would also offer guidance for the work of the Scientific Committee and its working groups in the development and adjustment of research priorities and workplans.

Some key issues that need to be considered by CCAMLR in the context of such a strategic plan for the krill fishery are discussed below, without aiming at being comprehensive.

5.1 Addressing the uncertainties

Scientific uncertainties could become obstacles to the full application of the ecosystem approach to fisheries management. As pressure from fishing interests to expand fishing effort increases, there is a risk that uncertainties will be used as a reason to oppose adequate management measures. While advice from the Scientific Committee incorporates mechanisms to deal with gaps in scientific knowledge, the complexity of the issues and the degree of uncertainty involved can complicate the formulation of conservation priorities and appropriate management measures (Hewitt & Low, 2000).

There is still a considerable degree of scientific uncertainty in relation to krill fisheries management. For example, we are still a long way from understanding the biology of krill to the point that would enable to predict how krill populations react to environmental changes (Kawaguchi & Nicol, 2007).

In relation to krill predators, most research has been conducted on land-based predators (fur seals and penguins). In spite of these efforts, better understanding of population sizes, diet and foraging ranges of key predator species is still needed. On the other hand, there is a gap in the understanding of the foraging ecology of pelagic krill predators as compared to land-based predators. For example, little is known about the dynamics of predator-prey interactions and the response of baleen whales to the distribution of their prey (Ainley *et al.*, 2006).

Furthermore, the distribution and abundance of krill between and within different areas of the South Atlantic needs to be better understood and will have important implications for management of krill fishing at the SSMU level.

An international workshop was convened by the *Lenfest Ocean Program* in May 2007 under the title "*Identifying and Resolving Key Uncertainties in Management Models for Krill Fisheries*". It gathered scientists from within and outside the CCAMLR community working on krill, krill predators and krill fisheries. The workshop identified uncertainties in relation to krill specific

issues, interaction of krill and predators, and the interactions of the krill-based ecosystem and the physical environment (including long-term changes).

In view of the current uncertainties, the application of the ecosystem approach to krill fisheries management will require a large investment in scientific research as well as effective coordination of national research programs. The International Polar Year (IPY, 2007-2008) provides for adequate international momentum which should be used by CCAMLR Members to foster increasing scientific research and cooperation on krill-related issues. In a CCAMLR policy context, existing mechanisms (i.e., scientific observation program) should be applied to krill and where needed, further mechanisms could be established, to ensure that the information required can be gathered.

5.2 The need for scientific observers and improving fisheries-related information

Key uncertainties in relation to krill biology that are relevant for fisheries management need to be addressed through the systematic deployment of scientific observers on board krill vessels. Such a scheme is needed to collect systematic biological samples of krill and related information that would allow CCAMLR to manage the krill fishery based on solid scientific advice.

Scientific Committee Members have agreed that scientific observers on board krill vessels are needed to provide essential data on: a) biology and distribution of krill; b) technological developments in the fishery; c) by-catch of fish (e.g., larval *C. gunnari*); d) incidental catches of seals and seabirds; e) mitigation measures, particularly the use and efficacy of seal-exclusion devices.

There is agreement at the Scientific Committee on the urgent need for systematic observer coverage on board the krill fishery, especially as a result of recent changes in the fishing/processing technology being used for krill. Details of the fishing operations of the different vessel technologies, and their respective potential ecosystem impacts need to be carefully evaluated through scientific observer information. This year's WG-EMM meeting highlighted the scientific need for increased observer coverage.

CCAMLR has been increasingly discussing the need for an observer scheme on board the krill fishery for nearly a decade -see Figure 2 below. Last year, the Scientific Committee repeatedly expressed the need for systematic scientific observation of all krill fishing activities. It also noted that "it still had inadequate information from the fishery on which to base management advice".²¹

At its latest 2007 meeting, WG-EMM considered a range of scientific reasons for high levels of observer coverage in the krill fishery. The working group noted that coverage is designed to understand the behaviour and impact of the fishery as well as routine monitoring to inform the modelling of krill stocks. The meeting made clear that the need for systematic coverage extends across all areas, seasons, vessels and fishing methods.

²¹ SC-CCAMLR, 2006), para. 2.5 - 2.8; 2.12 - 2.22; 3.4; 4.5; 4.8; 4.13; 4.20; 11.13 - 11.15; 15.16.

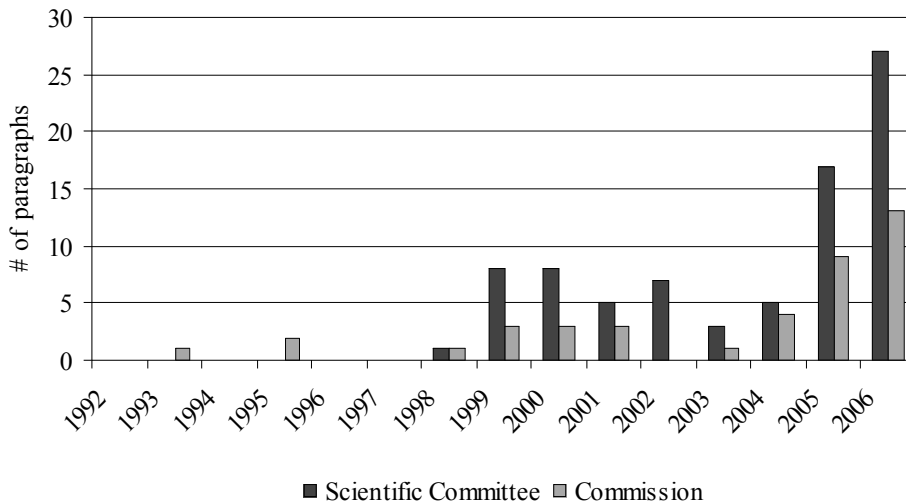


Figure 2. Number of paragraphs dealing with observer coverage on board krill vessels in Scientific Committee and Commission Reports 1992-2006.

At the most recent Scientific Committee deliberations on this issue, it has been clear that the reasons that are impeding this observer scheme to be adopted are political and not scientific. For example, at the last WG-EMM meeting in 2007, Members of the Working Group expressed their frustration that the collection of scientific observer data, which has been granted a high priority by the Scientific Committee, is being impeded by non-scientific arguments. The operational and financial constraints referred to by those Members that oppose mandatory observer coverage on the krill fishery have been overcome in other fisheries and there is no reason why they could not be overcome in the case of krill.

CCAMLR achievements in developing innovative approaches to fisheries management have been made possible in considerable part by the collection of data through CCAMLR's scientific observer program. Valuable information gathered by observers on aspects such as bycatch and operational fishing practices have enabled the development of key measures to minimize impacts on the Southern Ocean ecosystem as a result of fishing (Croxall & Trathan, 2004). It is paradoxical that CCAMLR has been unable to adopt a mandatory scheme of international scientific observation for the largest fishery under its jurisdiction - a fishery that targets a keystone species for the Antarctic marine ecosystem.

In addition to the data gathered through the scientific observer scheme, further data collection through fishery operations could contribute to answering key questions related to krill biology that are relevant for the management regime. Although CCAMLR Members have made collaborative efforts to undertake krill surveys in different areas of the Antarctic, little direct use has been made so far of the biological information arising from the commercial fishery for krill (Kawaguchi & Nicol, 2007).

It has been recently suggested that krill fishing vessels can gather and provide information in complementary ways to research vessels, offering some advantages to research cruises such as time spent at sea, increased number of tows, greater fishing depths, and the ability to target the

same areas or even the same krill aggregations year after year. If analysed in combination with data available from other sources, data gathered from fishing operators could become an invaluable source of information to deepen and widen the understanding of krill biology (Kawaguchi & Nicol, 2007).

Taking into account the level of uncertainty on krill biology, the potential for fishery expansion, and the information needs of an ecosystem-based management regime, CCAMLR should seriously consider the possibility of using krill fishing vessels as research platforms, as part of a strategic management plan for the krill fishery.

5.3 Integrating monitoring programs into a feedback management regime

As mentioned in section 2 above, CCAMLR has adopted in principle a feedback approach to krill fisheries management, which means that management measures need to be continuously adjusted to relevant information -as it becomes available- on the interactions between krill fishing and krill predators. Consequently, the CEMP was established with the main goal of detecting changes in predator indicator species as a result of fishing.

One of CCAMLR's key management objectives for the krill fishery is to preserve sufficient prey to sustain healthy predator populations. Therefore, integrating CEMP assessments of the impact of krill fishing on dependent species into long-term management procedures should be a key element of CCAMLR's strategic plan for krill management.

At the moment, the nature of CEMP can be described as a "surveillance monitoring" program, where basic ecological data are gathered allowing for a *posteriori* attribution of the causes of change, but there is no direct link between this monitoring program and a specific management objective. Although CEMP data have provided invaluable insights in the understanding of the key ecological processes in the South Atlantic and some other areas, implementing a feedback management procedure would require moving from current surveillance monitoring to "operational monitoring". The latter is designed to respond to a specific management objective, such as detecting whether a certain trigger level has been reached. The design and implementation of an operational monitoring program require clear definition of the change to be detected. Also, the monitoring should be designed so as to deliver the statistical power required to detect such a change (Reid, 2007).

It has been noted that the reasons why CEMP has not yet been translated into operational monitoring are related to a lack of definition about what constitutes an "acceptable level of impact" on krill predators (Reid, 2007). Although defining what constitutes such an acceptable level is a political decision, this should be guided both by CCAMLR conservation objectives, and sound scientific advice.

Currently, CEMP sites in Antarctica respond to shifting national priorities and are not necessarily coordinated around the need to respond to relevant questions for krill fisheries regulation in a feedback management context. CEMP sites are therefore not representative of all the areas that are being currently fished. Consistent, long-term data are available from three research programs

in Area 48 only, two of them (AMLR and Palmer-LTER) located in Subarea 48.1 (Antarctic Peninsula region), and one (BAS) located in Subarea 48.3 (South Georgia).

For example, currently there is predator monitoring in only one of the four SSMUs in Subarea 48.2 (South Orkneys). In Subarea 48.1, in spite of the long-standing research and monitoring efforts by the AMLR and LTER programs, monitoring only occurs in two of eight of the SSMUs in this region. In many of the SSMUs where krill fishing takes place, there is little information and monitoring which would be of use in a feedback management regime. As CCAMLR moves into SSMU-level management, the ability to effectively manage the fishery in those SSMUs where there is no monitoring will be very limited. In a feedback management context, it would be difficult to imagine how adaptive management measures can be developed for those SSMUs where fishing is occurring but no monitoring is being conducted.

In addition, predator monitoring is currently restricted to land-based predators. While this decision is consistent with the existing overlap between krill fishing areas and the foraging ranges of these predators, the question remains about how the potential impact of fishing on pelagic predators such as whales, crabeater seals or flying seabirds can be measured. Should the fishery start to expand to pelagic areas, this question would become more critical.

The monitoring of krill and krill predator populations as they respond to both the fishery and the environment is essential to reducing scientific uncertainty and adjusting management measures under a feedback regime (Hewitt & Low, 2000). At this critical moment of the development of the krill management regime, CCAMLR Members need to ensure that the expansion of the fishery is accompanied by a corresponding investment in the research and monitoring needed to develop a feedback management regime. For example, there is currently a mismatch between CCAMLR Members that contribute to CEMP work in areas that are being fished and Members that participate in the krill fishery.

Furthermore, CCAMLR's strategic plan for krill fisheries management should include the development of decision rules that would allow adaptive management through appropriate data arising from operational monitoring (as opposed to surveillance monitoring). On the basis of these decision rules, an analysis of the CEMP should be undertaken. This analysis can include questions such as location of additional monitoring sites, the need to add new species such as pelagic predators into the program,²² and indices to be measured. The potential use of area closures in the monitoring program in order to evaluate the effects of fishing (using closed areas as a control) should also be considered. Furthermore, the CEMP should be periodically reviewed to allow for adjustments in the design and operation of the program as required by feedback management needs.

5.4 Introducing precautionary measures to achieve conservation objectives

Implementing a full feedback management regime for krill fishing based on improved monitoring will take time. In the meantime, environmental effects, increased fishing pressure, or a

²² It has been suggested that collaboration with other bodies such as the International Whaling Commission or the Scientific Committee for Antarctic Research (SCAR) could provide useful in this regard (Hewitt & Low, 2000).

combination of both, may pose a threat to krill predators. CCAMLR needs to develop flexible and precautionary approaches in order to prevent irreversible impact on predator colonies as a result of fishing.

In the face of scientific uncertainty, ecosystem-based management regimes need to stay “risk averse”. If management is not averse to risk, more uncertainties would result in more aggressive fishing effort and not less (Rice, 2005). Given the level of uncertainty involved in ecosystem-based management of krill fishing, CCAMLR would need to limit krill catches in the short-term in order to accommodate both krill’s role in the ecosystem and periods of low productivity as a result of environmental forcing.

In this context, the establishment of a management regime at the SSMU level in the South West Atlantic (Area 48) should be incremental, so as to allow for the fishing effort to increase as more information becomes available for each SSMU, and adequate monitoring is in place to enable the implementation of feedback management measures in those SSMUs. Consequently, SSMU allocations could be increased over time as the understanding of environmental forcing factors and predator-prey interactions improves and functional relationships in the ecosystem are better identified.

CCAMLR already contemplated the need for applying precautionary measures to krill fishing in Area 48 when the trigger level was introduced. As explained in section 2 above, the goal of the trigger level was to ensure that fishing does not greatly exceed historical catches until an adequate management regime is in place.

The trigger level of 620,000 tonnes was established on the basis of summing the maximum historical krill catch in each subarea, which amounts to 619,500 tonnes. This approach was preferred to the alternative method of using the maximum catch in Area 48 as a whole in any one year, which amounts to 425,900 tonnes. Interestingly, the trigger level represents 194,100 tonnes (31 percent) in excess of the maximum historical catch ever taken in Area 48 in one single year.

In addition, although historical maximum catches in each subarea were used as a basis for the trigger level, the catch level associated to it does not contemplate any spatial allocation (that is, fishing under 620,000 tonnes can occur in any subarea). Thus, fishing effort could be distributed in a way that results in higher catch levels than historical being concentrated in a particular subarea. This situation may result in an unexpected localised impact on specific predator colonies, in the absence of small-scale management measures.

The comments above raise the question of whether the current trigger level is sufficiently precautionary to prevent localised impact on predators as a result of fishing. In any case, CCAMLR should ensure that fishing effort does not exceed the trigger level until it can be demonstrated that expanded fishing would not harm predator populations, or that mechanisms are in place that enable CCAMLR to detect or foresee potential harm and adjust management measures accordingly.

In addition, CCAMLR should also consider the possibility of developing additional precautionary, *ad hoc* management measures to address specific situations. For example, more stringent measures could be applied in years of expected reduced krill availability indicated by indices such as reduced average sea ice extent (Hewitt & Low, 2000). It has also been suggested that

establishing protective zones around islands, and periods of curtailed fishing during critical breeding periods could provide protection to krill predators without largely impacting on the fishery (Hewitt & Low, 2000).²³

5.5 Management of potential expansion of krill fisheries to new areas in Antarctica

Currently, krill fishing is taking place in subareas 48.1, 48.2 and 48.3 only. CCAMLR is working to develop a management regime at the SSMU level for these subareas in order to protect land-based predators from potential threats posed by krill fishing. The trigger level in Area 48 is aimed at ensuring that no expansion of the fishery occurs in these subareas before such a management regime is in place.

As interest in krill fisheries grows, the potential for the fishery to expand to other areas of the Southern Ocean increases. Currently, there are krill catch limits to fish for krill in Subarea 48.4, although no SSMUs are defined for that subarea. Krill catch limits exist for Statistical Divisions 58.4.1 and 58.4.2, but neither SSMUs nor trigger levels have been established for those areas. For the rest of the Southern Ocean, no krill catch limits have been developed and no krill biomass surveys have been conducted. Particularly, there are no catch limits for Area 88 and Subarea 48.6, where krill concentrations are known to be found (Everson, 2000).

CCAMLR should follow a consistent management model for krill fisheries across the Convention Area. This should include, as it is argued in this paper, the development of feedback management procedures based on ecosystem monitoring, the application of precaution to protect krill predators, the collection of biological data through scientific observation, and a set of MCS measures adequate to control krill fishing operations.

Precautionary measures should be taken to ensure that the potential expansion of the krill fishery to these other areas does not undermine CCAMLR's implementation of the ecosystem approach to krill fisheries management. CCAMLR already has mechanisms in place, such as new and exploratory fishery regulations, that would enable the Scientific Committee to develop a research plan prior to fishery development, especially in those areas where krill is known to be found and where the fishery can be expected to expand to. In addition, krill biomass surveys should be undertaken before the fishery starts to develop in those areas, and trigger levels should be established to account for the potential of localised impact on krill predator colonies.²⁴

5.6 Marine Protected Areas

CCAMLR is initiating work towards the development of a representative network of Marine Protected Areas (MPAs) in the Convention Area. To this end, a Bioregionalisation Workshop was held in Belgium in August 2007, with the main goal of advising the Scientific Committee and the

²³ The potential use of time/area closures to protect predators or to increase monitoring effectiveness was considered by the Scientific Committee in 1991. SC-CCAMLR, 1991, para. 3.84.

²⁴ At the last WG-EMM meeting, the working group put forward very specific recommendations for the development of new and exploratory fisheries for Area 88 and Subarea 48.6, including biomass surveys and the establishment of trigger levels.

Commission on possible approaches to a fine-scale subdivision of biogeographical provinces in the Southern Ocean.

The identification and assessment of areas of critical importance for krill productivity, as well as foraging and breeding areas of krill-dependent predators, should be an important aspect in the development of MPAs in the CCAMLR Area. For example, it is believed that the Western Antarctic Peninsula is an important area for reproduction and recruitment of krill for the entire South West Atlantic. In the context of the development of an MPA network, and taking into account the vital role of krill in the Antarctic ecosystem, protection of relevant areas such as the Western Antarctic Peninsula should be given consideration.

5.7 Keeping control of fishing operations

The implementation of the ecosystem approach to the management of the Antarctic krill fishery is a central task for CCAMLR. The Scientific Committee, through the work of WG-EMM and more recently WG-SAM, has devoted considerable attention to issues related to the ecosystem and management implications of krill fishing. Regrettably, the quality and magnitude of CCAMLR's scientific work on krill is rarely matched by action at the Commission level to provide the necessary tools to allow adequate monitoring and control of the fishery.²⁵

It is paradoxical that while CCAMLR's scientific work on krill is regarded as a model at the regional level, this fishery is still exempt from basic control requirements that apply to other CCAMLR fisheries. Without an adequate set of MCS measures, all the resources invested in developing a solid, scientifically sound ecosystem-based management regime would be fruitless.

a. Centralised Vessel Monitoring System

Vessel Monitoring System (VMS) is a basic regulatory tool that allows States to verify that fishing operations comply with the conditions of the fishing licence and that fishing in non-authorised areas does not occur. CCAMLR introduced the VMS in 1998, requiring flag States to monitor the position of its fishing vessels licensed to fish in the Convention Area through an automated satellite-linked VMS.²⁶ Since its adoption, krill vessels have been exempt from the requirement to carry a VMS, which applies to all other CCAMLR fisheries.

CCAMLR's VMS has been strengthened in recent years to include more complete information to be reported to the flag State, which now includes not only general fishing vessel identification and position, but also specific data on the geographical position of the vessel, date and time of said positions, and speed and course of the vessel. These data must be reported at minimum every four hours. The VMS has also been revised to include specific requirements that make the system less amenable to tampering. Most importantly, at its 2004 meeting, CCAMLR established a centralised VMS (cVMS), by which flag States are required to transmit the position of the

²⁵ See ASOC, Improving monitoring and control of the krill fishery. CCAMLR–XXV/BG/27.

²⁶ See CM 10-04 (2005).

vessels to the CCAMLR Secretariat, which allows for independent verification of vessel positioning data.

The Commission has discussed the need to require VMS on board krill vessels on several occasions. While most CCAMLR Members have been in favour of VMS, opponents have argued that the total krill catch is currently well below the catch limit and VMS is therefore unnecessary. However, with notifications to participate in the krill fishery in 2007/08 exceeding the 620,000 tonnes trigger level, the adoption of this measure becomes a matter of urgency. When catch limits at the SSMU level are in place, it will be impossible to ensure compliance without cVMS on all krill vessels. Introducing this regulation in advance will avoid possible implementation delays. Previous experiences at CCAMLR have shown that it is more difficult to reach consensus on these types of regulatory adjustments when the need for them has already become imperative (Constable *et al.*, 2000).

In addition, cVMS will be needed to ensure that krill catches do not go over the trigger level in Area 48 in the upcoming season. Flag States need to be able to track vessel positions in order to ensure that catches in Area 48 are not misreported as taken elsewhere. Without cVMS, the krill fishery is poorly regulated and difficult to monitor.

b. Reporting requirements

Although good progress has been made in recent years²⁷ on the information requirements about krill fishing and krill fishing plans, the krill fishery is still a long way from other CCAMLR fisheries in relation to the information required by the fishery which is needed for effective management.

For example, the krill fishery is the only CCAMLR fishery that does not require the reporting of biological data. CM 23-06, which establishes the “Monthly Fine-Scale Biological Data Reporting System for Trawl, Longline and Pot Fisheries”, is applicable to all species targeted by fisheries in the CCAMLR Area except for krill. Taking into account current information needs in relation to krill biology, it is anomalous that this conservation measure does not apply to krill fishing.

Another important issue relates to reporting requirements and the use of new methods for krill fishing. In 2005, the Scientific Committee noted that with the new technology being used to catch krill, the duration of a haul can extend for several days, and therefore, a single haul can occur in several different SSMUs. CM 23-06 was adapted accordingly, and it now requires catches to be reported “*according to the statistical areas, subareas, divisions, or any other area or unit specified with catch limits in Conservation Measures 51-01, 51-02 and 51-03*”. This means that, when catch limits are established for SSMUs in Area 48, catches will have to be reported at the SSMU level on a monthly basis, in addition to providing haul-by-haul, fine-scale data at the end of the fishing season.

At the moment, vessels report fine-scale data with different levels of detail depending on the fishing method. There are still problems associated with the reporting of biological, catch and

²⁷ In 2005, CM 23-06 (2005) was amended to require annual submission of haul-by-haul data. In 2006, CM 21-03 (2006) was adopted, implementing a notification procedure for participating in krill fisheries.

effort data on appropriate spatial and temporal scales from the continuous pumping system.²⁸ Vessels using the continuous pumping method should be required to develop means that allow reporting measured catches at 2-hour time intervals.

Another important regulatory gap in relation to reporting requirements for krill has to do with the Catch and Effort Reporting System that allows the CCAMLR Secretariat to monitor fishing catches as the fishing season develops. CM 23-06 (2005) sets up the data reporting system for krill fisheries. It refers to the monthly catch and effort reporting system set out in CM 23-03, which means that at the end of its calendar month, each Contracting Party shall obtain from its fishing vessels its total catch and total days and hours fished for that period. These data are transmitted to the Executive Secretary. In most finfish fisheries, catch and effort data are due on a basis of 5-days period (CM 23-01), which allows the Secretariat to predict when the total allowable catch is likely to be reached for that season and for the fishing season to be closed around that date.

Until now, monthly reporting of krill catch and effort data was sufficient for krill as the prospects for reaching the trigger level on a single season were remote. However, with notifications for the upcoming season surpassing the trigger level in Area 48 by 136,000 tonnes (and exceeding the limits in Division 58.4.1 of 440,000 tonnes and 58.4.2 of 450,000 tonnes), it is imperative for CCAMLR to amend the reporting system for krill fisheries and establish a 5-day reporting period for krill, which would make it possible to close the fishery when a certain limit –i.e., the trigger level- is reached.

5.8 Dealing with IUU fishing

As shown in recent krill fishery catch data, and notifications of fishing plans for the upcoming season, Antarctic krill fishing is already occurring under flag States that are not Members of the Commission. As the management regime is strengthened and regulations become more stringent, fishing companies will have an incentive to operate under flags of convenience with limited capacity to exert real control over their vessels.

Krill fishing by non Commission Members has been occurring for several years now. In relation to Vanuatu's intent to fish for krill in the CCAMLR Area, last year the Commission expressed concern over this State's capacity to exercise full Flag State control over these fishing activities. In this context, the Secretariat was asked to request Vanuatu to become a full member of the Commission if Vanuatu-flagged vessels were to continue fishing for krill in the CCAMLR Area. In addition, several Members recommended "that Vanuatu be asked to withdraw their vessels from the fishery until such time as Vanuatu had become a full Member".²⁹

CCAMLR has a long history of dealing with Irregular, Unregulated and Unreported (IUU) fishing in the Convention Area and has mechanisms in place that could be made applicable to krill in order to remove incentives to IUU fishing for krill.

²⁸ SC-CCAMLR, 2006, para. 4.17.

²⁹ SC-CCAMLR, 2006, para. 7.25.

In this context, CCAMLR has developed a set of port and trade measures to control landings of fish catches that has proved useful in combating IUU fishing for toothfish. For example, CM 10-03 (2005) establishes specific port State inspection procedures for vessels carrying toothfish that enter ports of Member countries. This includes the requirement for an advance notice of entry into port, and the requirement that fishing vessels provide a written declaration that the vessel has not undertaken IUU fishing in the Convention Area.

CCAMLR has also adopted IUU Vessel Lists for Contracting and non Contracting Parties. Pursuant to CM 10-06 (2006) and 10-07 (2006), vessels listed in the IUU Vessel Lists should not be reflagged by CCAMLR Members, should not be granted further licenses to fish in the CCAMLR Area, should be denied port access by CCAMLR Members, and should be denied any kind of assistance or joint fishing operations by vessels flagged to CCAMLR Members. CM 10-06 and 10-07 are applicable to IUU fishing for all species in the Convention Area. Therefore, CCAMLR should stand ready to list IUU krill vessels if required.

6. RECOMMENDED REGULATORY REFORMS TO BE ADOPTED AT CCAMLR XXVI

The full implementation of a strategic plan for the management of krill fisheries will require a series of regulatory reforms, including, among others, the establishment of krill catch limits at the SSMU level based on feedback management procedures, a set of MCS measures, and the possible adoption of additional precautionary measures to protect krill predators in specific situations.

At its XXVI meeting, the Commission should adopt the following urgent reforms in the application of the ecosystem approach to krill fishing:

a) Scientific observers on board

CCAMLR should adopt a mandatory scheme for scientific observers on board krill vessels in accordance with the CCAMLR Scheme of International Scientific Observation. A mandatory scientific observer scheme is urgently needed to collect systematic biological samples of krill and related information that would allow CCAMLR to manage the krill fishery based on solid scientific advice. In addition, this reform will bring krill fishery regulations in line with other CCAMLR fisheries, as currently the krill fishery is the only significant CCAMLR fishery which is exempt from the requirement to have scientific observers on board.

This reform will require amending Conservation Measures 51-01, 51-02, and 51-03 to add the following paragraph: *Each vessel participating in the fishery shall have at least one international scientific observer on board throughout all fishing activities within the fishing period, appointed in accordance with the CCAMLR Scheme of International Scientific Observation.*

b) cVMS

CCAMLR should require all krill-fishing vessels to maintain a Vessel Monitoring System under the same requirements applicable to other CCAMLR fisheries. To achieve this, the provision in CM 10-04 (2005) that exempts krill vessels from cVMS should be removed.

c) Reporting of biological data

The krill fishery is the only CCAMLR fishery that does not require the reporting of biological data. CM 23-06, which establishes the “Monthly Fine-Scale Biological Data Reporting System for Trawl, Longline and Pot Fisheries”, should be applicable to all species targeted by fisheries in the CCAMLR Area with no exception.

d) Catch and Effort reporting on 5-days period basis

CCAMLR should amend the reporting system for krill fisheries and establish a 5-day reporting period for krill, which would make it possible to close the fishery when a certain limit is reached.

e) Application of port State inspections to krill vessels

As a first step towards deterring IUU fishing for krill, CCAMLR should extend the application of CM 10-03 (2005) on port State inspection procedures to krill fishing vessels.

f) Application of new and exploratory fisheries requirements to krill fishing in new areas

An exploratory fishing application should be required for fishing in areas where no catch limits have been established (i.e., Area 88 and Subarea 48.6). Prior to fishing in these areas, biomass estimates should be undertaken and trigger limits should be established.

7. CONCLUDING REMARKS

CCAMLR Members are the stewards of krill and krill predators, and of the wider Antarctic marine ecosystem. This notion is embedded in the formulation of Article II of “rational use” of Antarctic marine living resources. Consequently, the health of krill predator populations is as important to the success of CCAMLR management as is the status of krill stocks (Hewitt & Low, 2000).

Although currently the risk of overexploitation of krill populations appears to be small, economic incentives for an increased krill catch are already in place (as shown by the large increase in notifications for krill fishing in 2007/08). Most importantly, there is potential for local impact on vulnerable land-breeding predator colonies, taking into account the spatial overlap between the krill fishery and the foraging ranges of these predators. Should the fishery expand to pelagic areas, greater uncertainties would need to be carefully considered, as information on pelagic predators foraging needs and responses to changes in krill availability is even scarcer than in the case of land-breeding predators.

Many international fisheries regimes have failed in preventing overexploitation of marine resources and the subsequent impact on marine ecosystems. Reactive management or the practice of taking management action only when the need for it has become apparent, has been identified as an important factor in these failures, and was rejected by CCAMLR as a long-term strategy for the krill fishery.³⁰

CCAMLR retains now a unique window of opportunity to develop a strategic plan for krill management that follows the ecosystem approach, including the development of feedback management procedures at small-scale management levels so as to ensure that krill predator populations are not threatened by fishing.

³⁰ SC-CCAMLR, 1991, para. 3.103.

As part of CCAMLR's strategic plan for krill fisheries management, and until adequate feedback management procedures are developed and implemented, CCAMLR needs to ensure that fishing for krill does not exceed historical levels, especially in those areas that are close to land-breeding predators.

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